

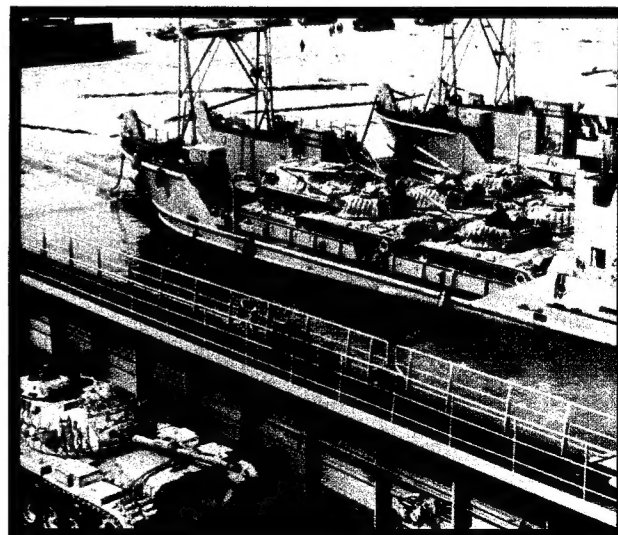
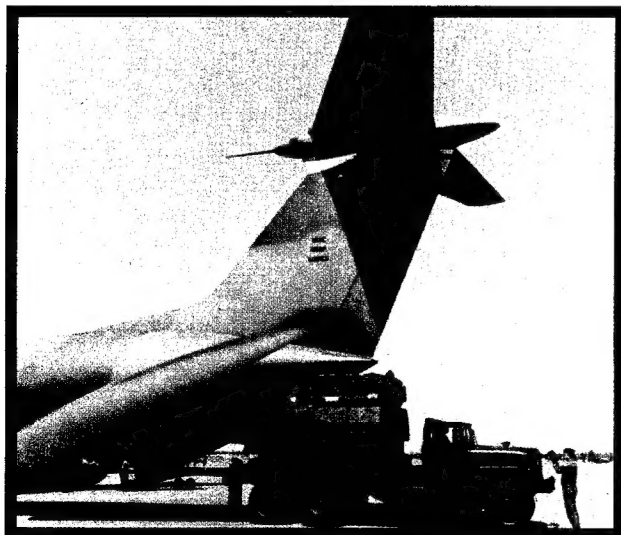
MTMCTEA REFERENCE 94-70-1

TRANSPORTABILITY AND DEPLOYABILITY

FOR BETTER

STRATEGIC MOBILITY

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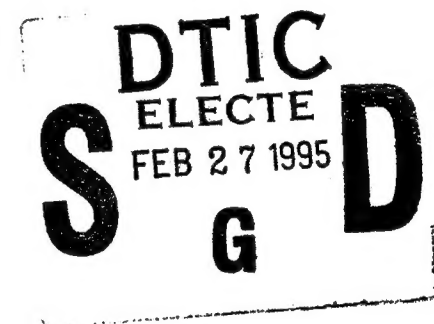
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TRANSPORTABILITY AND DEPLOYABILITY FOR BETTER STRATEGIC MOBILITY

SEPTEMBER 1994*



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INTRODUCTION

Properly applied transportability engineering is essential to the deployment of military equipment. An item of equipment is of little value if it cannot be transported rapidly and efficiently to where it is needed. This publication is a guide to transportability. It is intended for everyone interested in transportability: decision makers, materiel developers, combat developers, equipment designers and users, logisticians, and transporters. It is not designed to make you an instant transportability expert, but to help you understand the Engineering for Transportability program and the various transport modes. Transportability criteria are given in **MIL-STD-1366**. This publication is organized by the following sections:

I. TRANSPORTABILITY DEFINITION

This section provides insight into the Engineering for Transportability program, transport modes and limitations, and the acquisition cycle.

What is transportability?

Why is it important?

How does it fit into the acquisition cycle?

II. TRANSPORTABILITY REQUIREMENTS

This section explains different transportability requirements and the limitations associated with each requirement.

How should transportability requirements be determined?

How should they be written?

III. TRANSPORTABILITY DESIGN

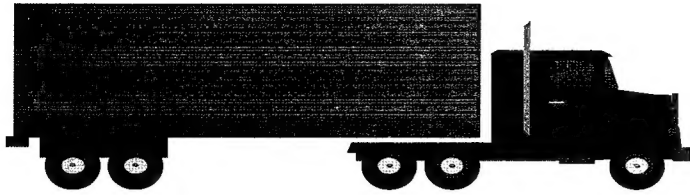
This section reviews some Do's and Don'ts of transportability design.

IV. TRANSPORTABILITY APPROVAL

This section discusses which items need transportability approval, how approval is requested and obtained, and what the data requirements are for approval.

What is transportability approval?

How is it obtained?



SECTION I



TRANSPORTABILITY DEFINITION



1. BACKGROUND

TRANSPORTABILITY QUESTIONS???

WHAT?

Transportability is the inherent capability of materiel and units to be moved efficiently by existing or planned transportation assets.

WHEN?

Begins by concept exploration (preferably earlier) and continues throughout procurement. The effect of transportability on total force deployability, and the required modes of transportation, should be determined by Milestone 0. Transportability characteristics must be sent to MTMCTEA no later than 90 days prior to each Milestone.

WHERE?

DODI 5000.2, *Defense Acquisition Management Policies and Procedures*, states, "When designing new or modified equipment, transportability criteria for all possible modes of transportation will be considered and their limiting characteristics identified."

AR 70-44/OPNAVINST 4600.22B/AFR 80-18/MCO 4610.14C/DLAR 4500.25, *DOD Engineering for Transportability*, establishes the DOD Engineering for transportability program.

AR 70-47, *Engineering for Transportability*, supplements AR 70-44*

*AR 70-44 is under revision. When approved, the revised version will replace ARs 70-44 and 70-47. Henceforth, in this publication we will use AR 70-44/47 to designate the current and revised versions.

MIL-STD-1366, *Transportability Criteria*, lists criteria for all modes.

WHO?

All officials must consider transportability essential for all acquisitions.

Project managers are key players.

HOW?

AR 70-44/47 tells how to apply for transportability approval and lists requirements for a transportability engineering analysis. (Transportability approval is required prior to engineering and manufacturing development as well as prior to production and fielding.)

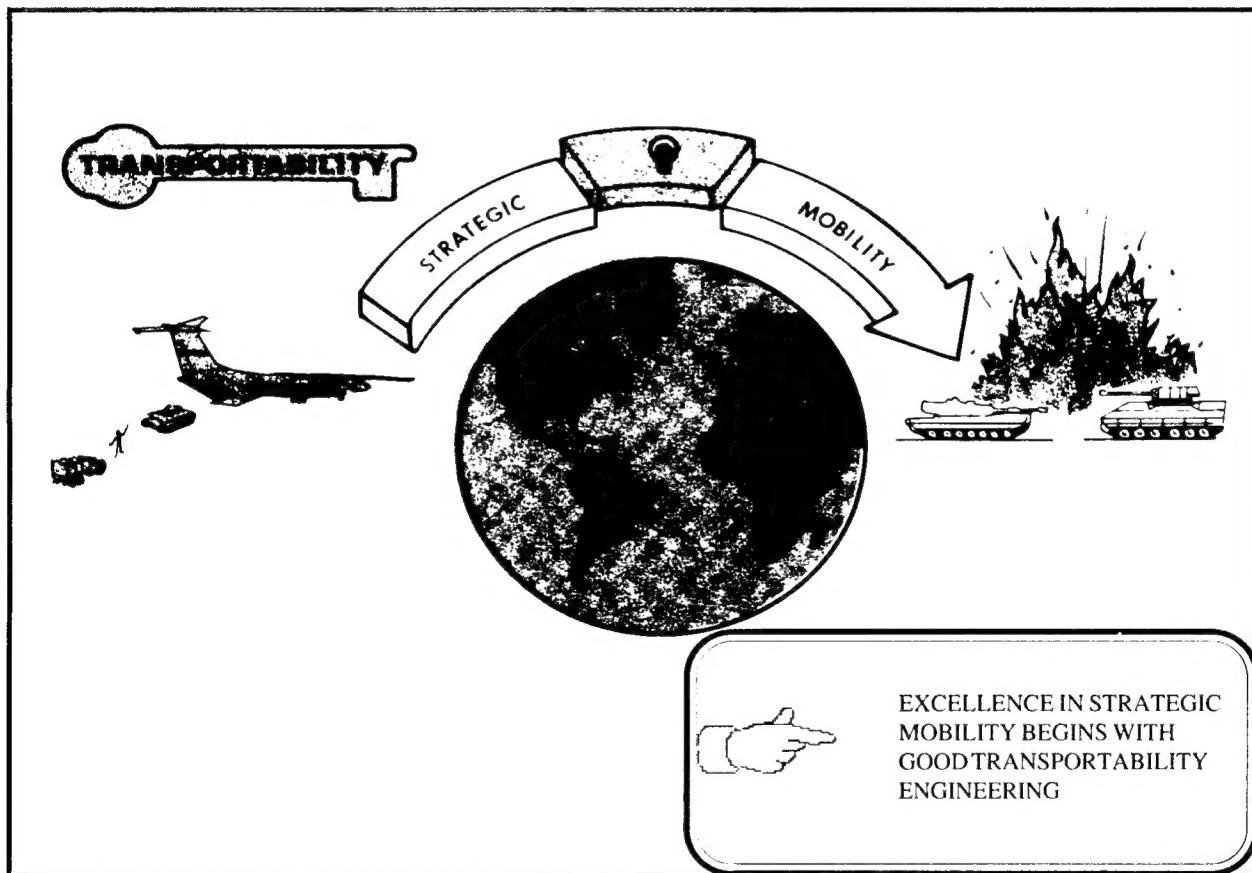
WHY?

- To get COMBAT POWER to its place of business QUICKLY.
- To support the post-Cold War CONUS-based force.
- To cut response time.
- To reduce airlift sorties.
- To reverse heavy-up trend.
- To use transportation assets efficiently and safely.
- To improve strategic and tactical mobility.
- To comply with **DODI 5000.2** and **ARs 70-1, 70-44/47, and 71-9.**

TRANSPORTABILITY AND STRATEGIC MOBILITY

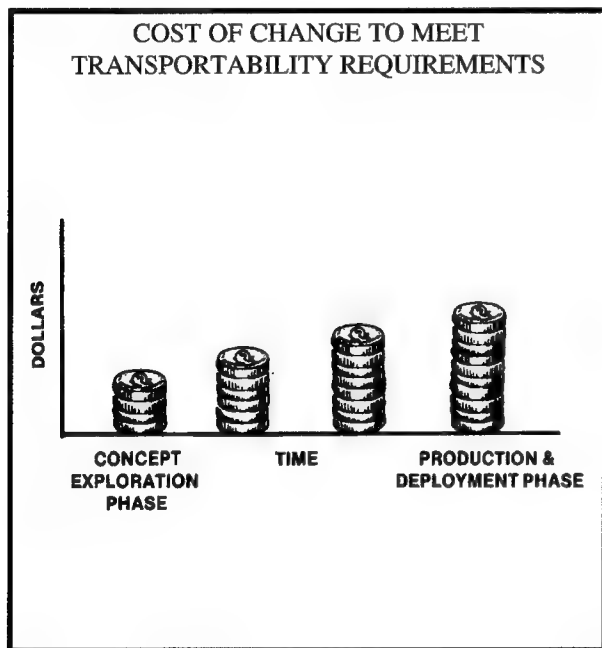
Transportability is the keystone of strategic mobility. Without proper transportability, the strategic mobility bridge would weaken to the point of collapse. Materiel and units that are not easily transportable cannot be readily deployed and are of little value when a mission requires quick response. No matter how capable a piece of equipment or unit may be, if it cannot be transported rapidly to a conflict point when needed, that capability is useless. A less capable, but fully transportable, piece of equipment or unit is of more value, especially when quick

response is essential. The effect of equipment on the *quantity* of transportation assets must also be taken into account. Obviously, it is much more desirable to deploy units that require fewer cargo aircraft or ships for transport. A rapidly deployable unit that uses an excessive amount of cargo space can prevent other units from being rapidly deployed and hurt the strategic mobility of the total force. Fully transportable materiel and units will ensure full strategic mobility when rapid deployment is essential.

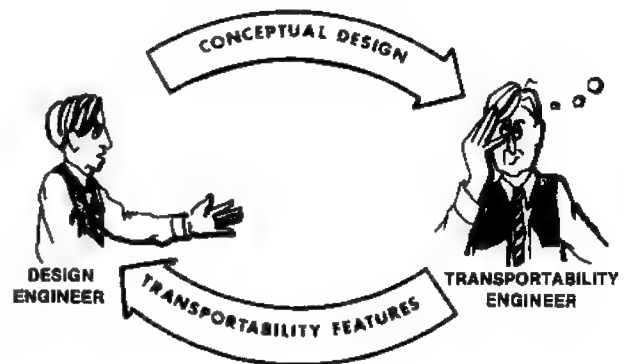


DESIGN INFLUENCE

Transportability is both an Integrated Logistic Support (ILS) element and a design element. **DODI 5000.2** states, "Transportability shall be a major consideration in ... the design of any new or modified equipment..." Transportability, therefore, must have a significant influence on the design of an item being procured. This influence is greatest at the beginning of the acquisition cycle because the costs for design changes are minimal during conceptual design. Once the conceptual design is converted to hardware, costs for changes increase dramatically.



The item design engineer should ensure that all the transportability requirements have been incorporated into the item design as early as possible in the acquisition cycle. The transportability of all associated support items also should be planned for as early as possible. Early coordination with MTMCTEA transportability engineers is the best way to ensure that an item will meet its transportability requirements.



Transportability considerations are also important to advanced technology demonstrators and premilestone I concepts. An important justification for proceeding with development and fielding of a new weapon system is that it will improve deployability of the total force of the future.

2. TRANSPORTATION MODES AND LIMITATIONS

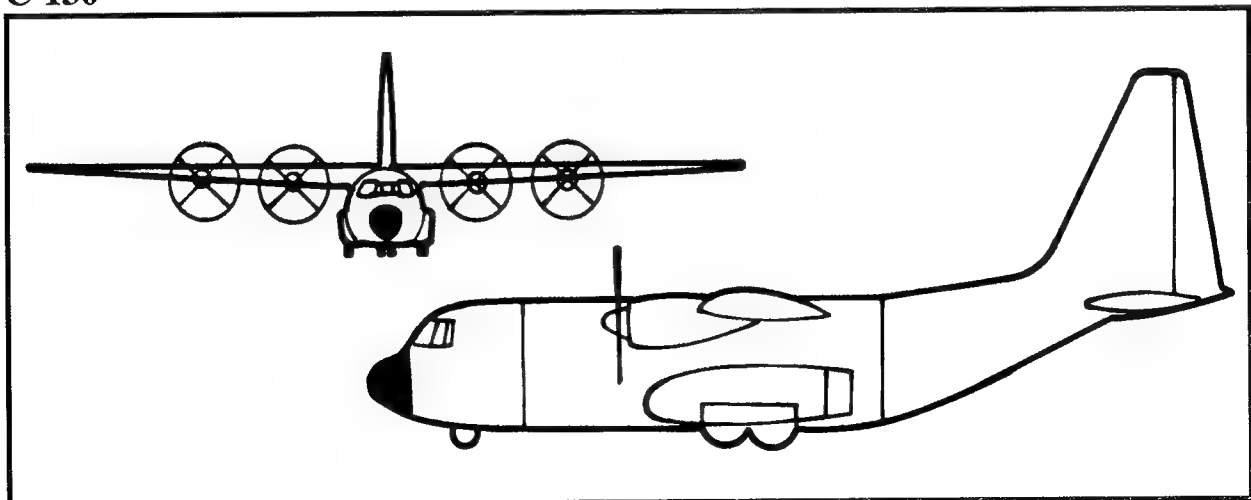
Transportability is the inherent capability of materiel and units to be moved efficiently by existing or planned transportation assets. This chapter provides insight into the transport modes and assets. It also includes a discussion of transport limitations and their impacts.

AIR (FIXED WING)

Air transport by fixed wing aircraft is the most important transport mode in terms of rapid strategic mobility. This mode has the greatest demand and the most limited assets. The need for equipment to be transportable by the C-130 and C-141, in addition to the larger C-5 and C-17, cannot be overemphasized. Equipment that is designed to be air transportable only by the C-5 and/or C-17 must be approved by the appropriate service HQ staff elements. Air transport has definite cargo size and weight limitations that

must be met in the design and acquisition of military equipment. The fixed wing aircraft available for transporting military equipment are the US Air Force C-130, C-141, C-17, and C-5 and the Civil Reserve Air Fleet (CRAF). These aircraft are expected to remain in service until well into the 21st century. The data in this section are general. Specific requirements are in **MIL-STD-1791**, *Designing for Internal Aerial Delivery in Fixed Wing Aircraft*.

C-130



The C-130, a four-engine, high-wing aircraft, is used mainly as a tactical, intratheater aircraft. It is not intended for use as a long-haul aircraft to strategically deploy military equipment. The C-130 is loaded through an aft cargo door.

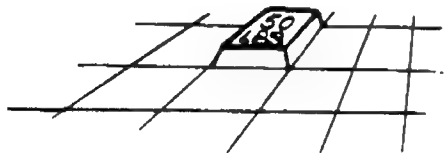
The dimensional design limits for equipment to be transported in the C-130 are:

Height: 102 inches
Length: 480 inches
Width: 107 inches

(The C-130 has a permanently installed rail system that limits the floor width to 105 inches. This limitation is in effect to a height of 5.5 inches.)

These design limits allow for 6 inches of safety clearance between the equipment being loaded and the aircraft ceiling and sidewalls.

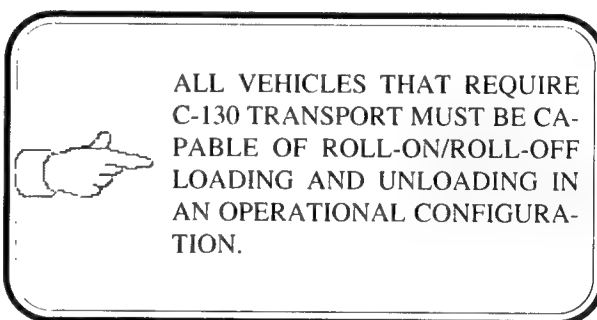
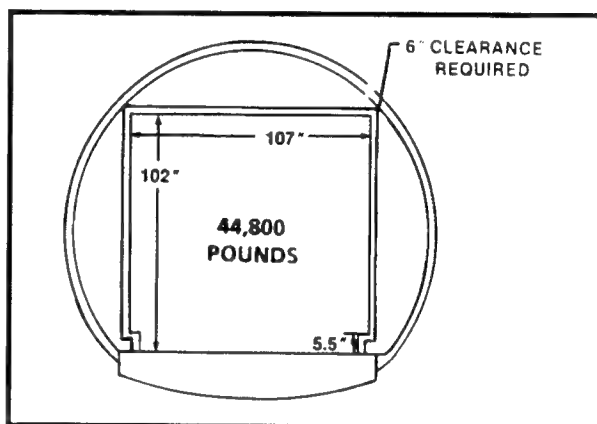
The maximum concentrated load for bulk cargo on the floor of a C-130 is 50 pounds per square inch (psi).



The maximum peacetime payload for the C-130 is 44,800 pounds. However, aircraft operating weight and range also must be considered. The practical payload limit is about 25,000 pounds in

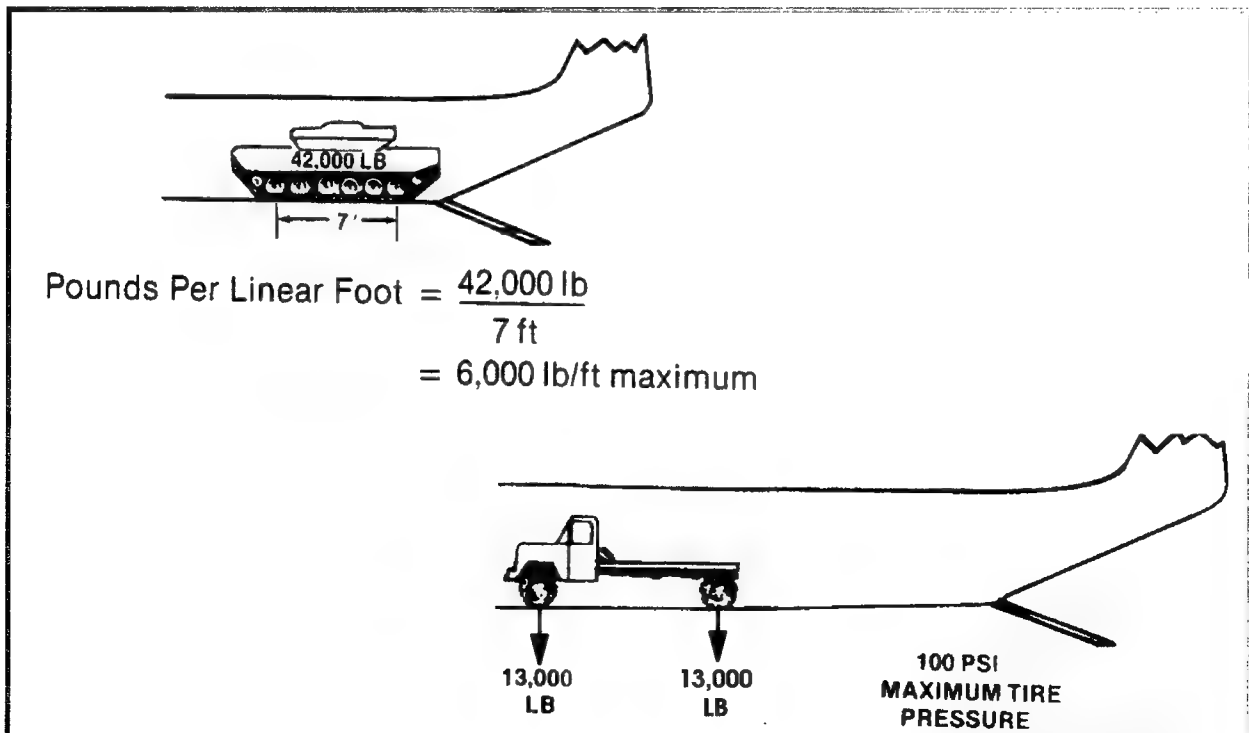
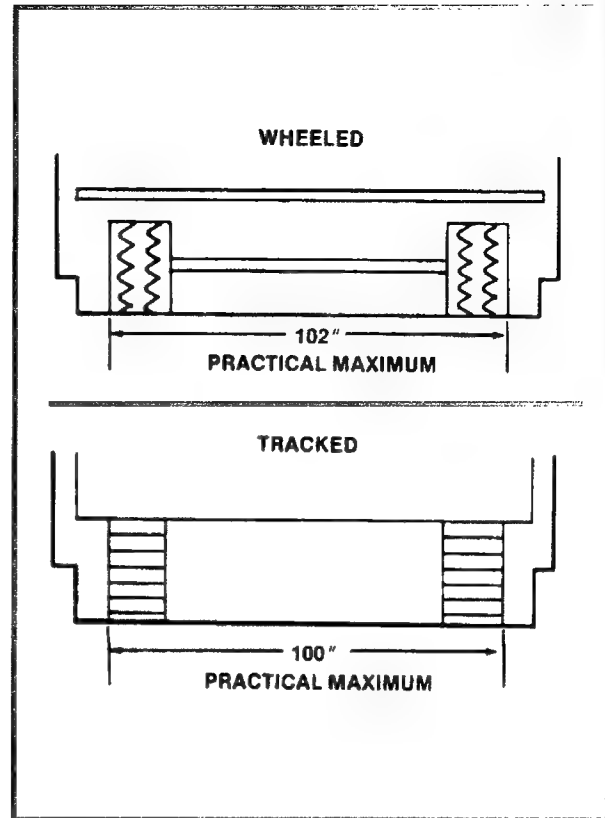
most cases, after making an allowance for fuel weight.

An adequate safety aisle is required so that, during flight, the aircraft loadmaster can move from the forward to the aft end of the cargo compartment. Safety aisle dimensions should be 14 inches wide by 66 inches high or 30 inches wide by 42 inches high.

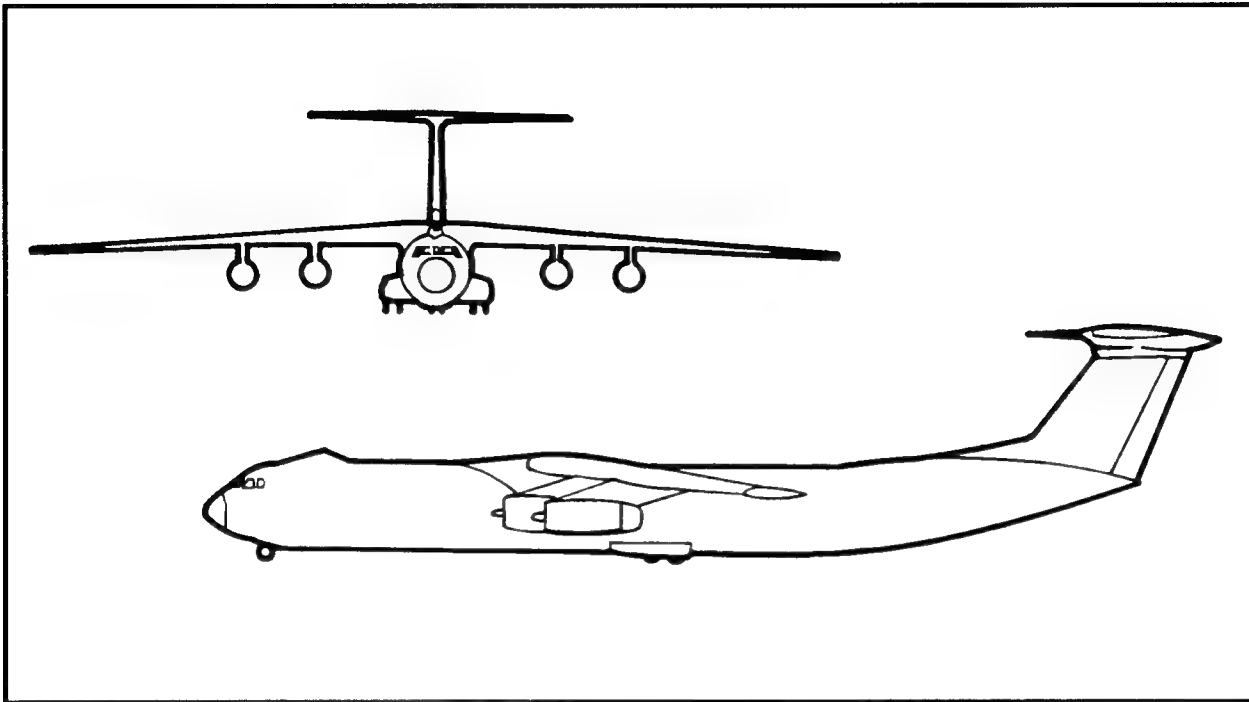


The practical maximum floor widths for roll-on/roll-off operations of wheeled and tracked vehicles are 102 and 100 inches, respectively. The

maximum axle load with pneumatic tires on the C-130 treadways is 13,000 pounds, provided the tire inflation pressures do not exceed 100 psi. Axle loads between 6,000 and 13,000 pounds are limited to a 28.75-foot portion of the aircraft (fuselage stations (FS) 337 to 682). The maximum axle load with pneumatic tires between the C-130 treadways is 5,000 pounds. The maximum load on the C-130 treadways for tracked vehicles is 6,000 pounds per linear foot of track in contact with the aircraft floor (3,000 pounds per linear foot for each treadway). Loads between 2,800 and 6,000 pounds per linear foot of track length in contact with the aircraft floor (1,400 and 3,000 pounds per linear foot for each treadway) are limited to a 28.75-foot portion of the aircraft (FS 337 to 682).



C-141

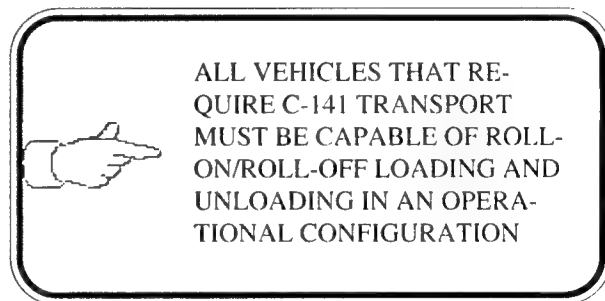


The USAF C-141, a high, sweptback wing jet aircraft, is mainly used as a strategic, intertheater aircraft. The C-141 is loaded through an aft cargo door. The dimensional design limits for equipment to be transported in the C-141 are:

Height:	103 inches
Width:	111 inches
Length:	1,090 inches

These design limits allow for 6 inches of safety clearance between the equipment being loaded and the aircraft ceiling and sidewalls.

The maximum peacetime payload of the C-141 is 68,600 pounds. However, aircraft operating weight and range also must be considered. Without refueling, the C-141 will be limited to a payload of 50,000 pounds in most cases.



The maximum concentrated load for bulk cargo on the floor of the C-141 is 50 psi on and outboard of the treadways and 25 psi between the treadways.

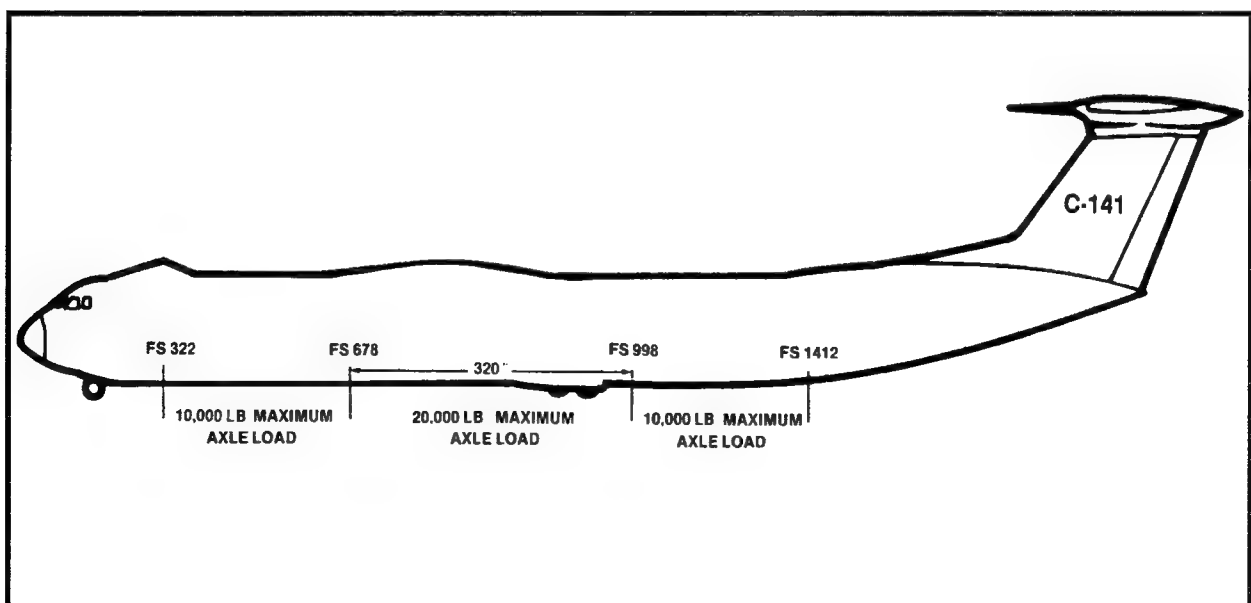
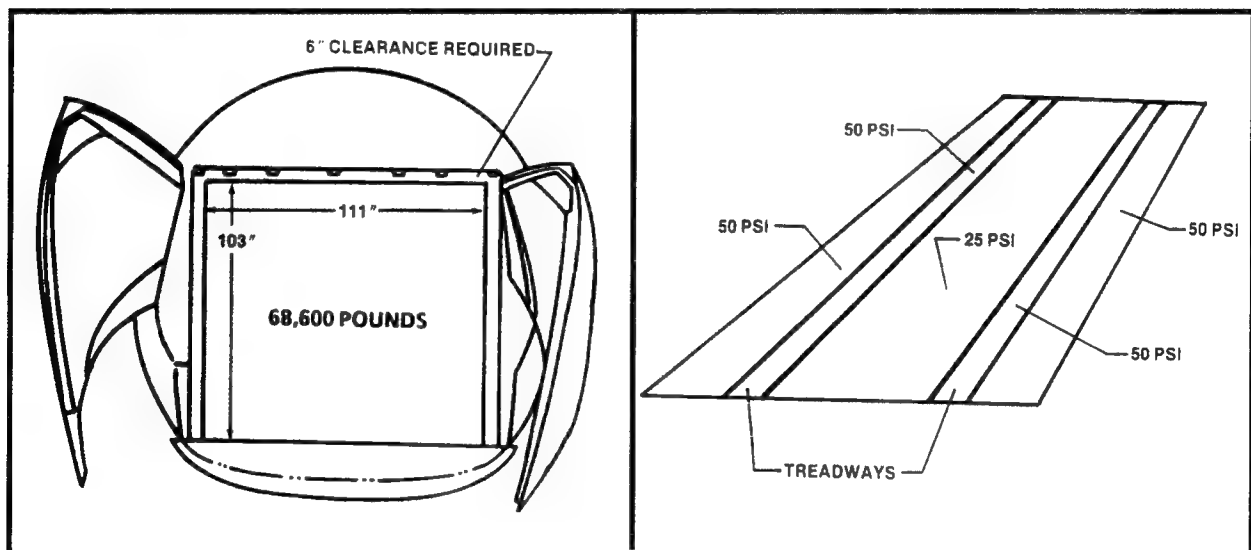
The maximum axle load for pneumatic tires on or outboard of the treadways on the C-141 is 20,000 pounds. Axle loads between 10,000 and 20,000 pounds are limited to a 26.7-foot portion of the aircraft (FS 678 to 998).

The maximum wheel load with pneumatic tires on and outboard of the C-141 treadways is 5,000 pounds for tire sizes less than 14 x 17.5. Otherwise, the wheel load is one-half the axle load limit, provided the tire and rim are within their highway rating and the inflation pressure is less than 100 psi. The maximum tire inflation pressure allowed on the C-141 is 100 psi.

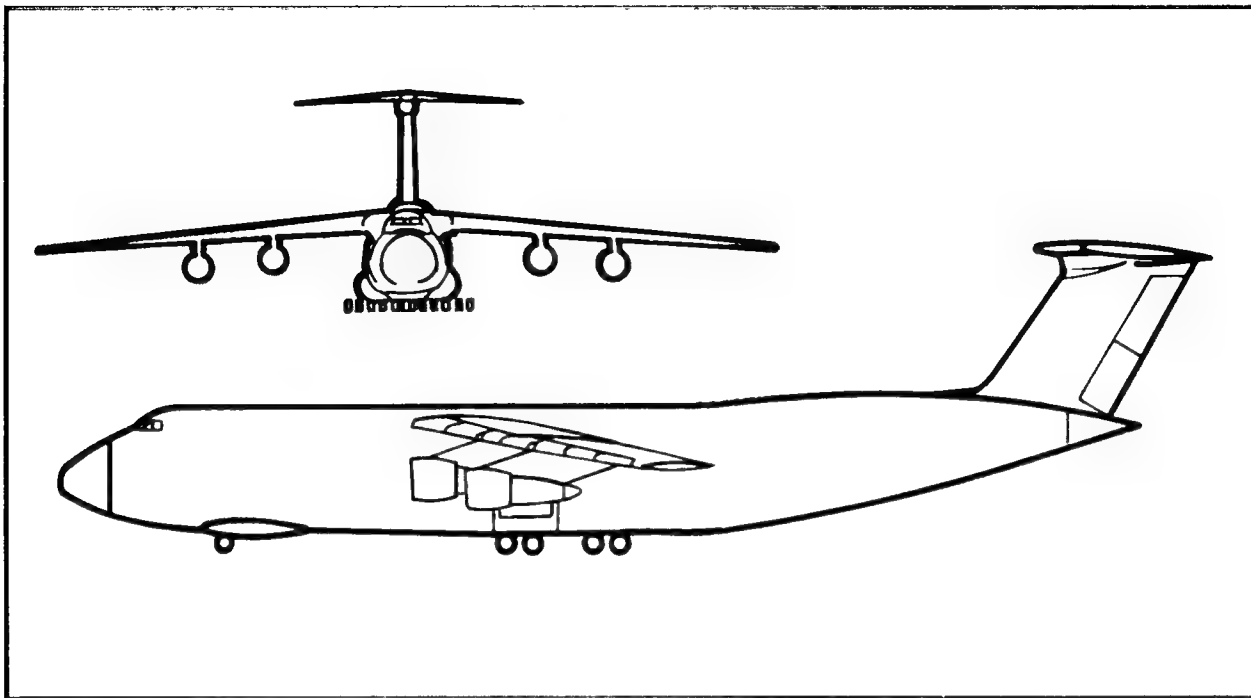
The maximum practical weight for C-141 transport of tracked vehicles is 44,000 pounds. Tracked

vehicles with snubbed, chained-down, or nonarticulating ("beam") suspension that exceed 32,500 pounds must be straight-in loaded/unloaded from/onto a loading bed (K-loader or M870 semitrailer). The maximum axle weight of a tracked vehicle is 10,000 pounds; however, 3 inches of shoring will be required.

If no shoring is to be used, the maximum axle weight of a tracked vehicle is 5,000 pounds for tracks with pads.



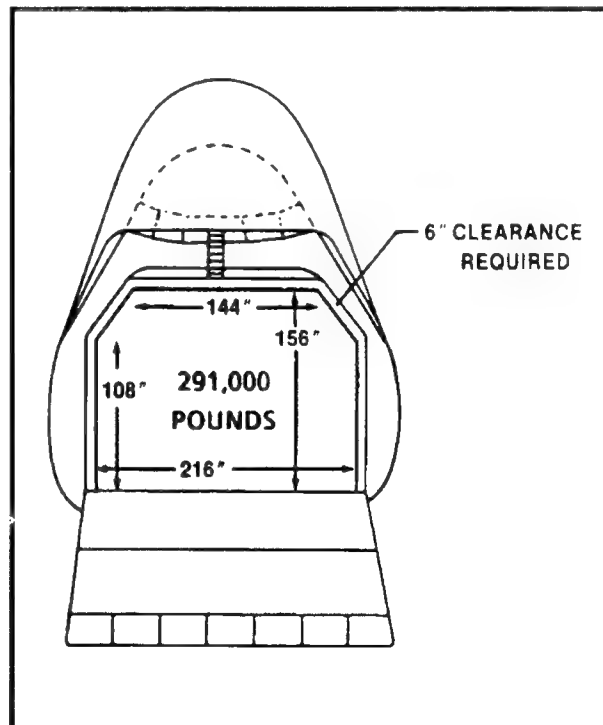
C-5



The USAF C-5, a high-speed, high-capacity, long-range jet aircraft, is mainly used as a strategic, intertheater aircraft for transporting cargo and troops. The C-5 can be loaded through either a forward visor door or an aft door under the tail. Both doors come equipped with cargo ramps. The dimensional design limits for equipment to be air transportable in the C-5 are:

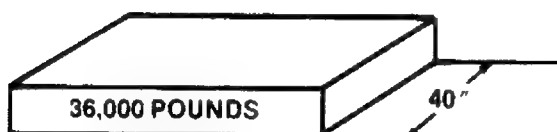
Height:	156 inches
Width:	144 inches (216 inches if height is less than 108 inches)
Length:	1,454 inches

These design limits allow for 6 inches of safety clearance between the equipment being loaded and the aircraft ceiling and sidewalls.



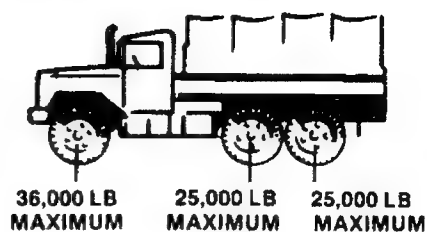
The maximum payload of the C-5 is 291,000 pounds. However, aircraft operating weight and range also must be considered. A more typical payload, considering fuel weight, is 150,000 pounds.

The strongest portion of the C-5 floor is capable of supporting loads of 36,000 pounds in any 40-inch longitudinal length of floor.

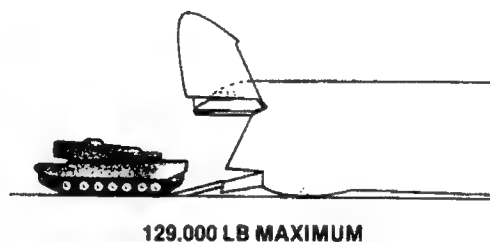


The maximum single-axle load allowed on the C-5 is 36,000 pounds.

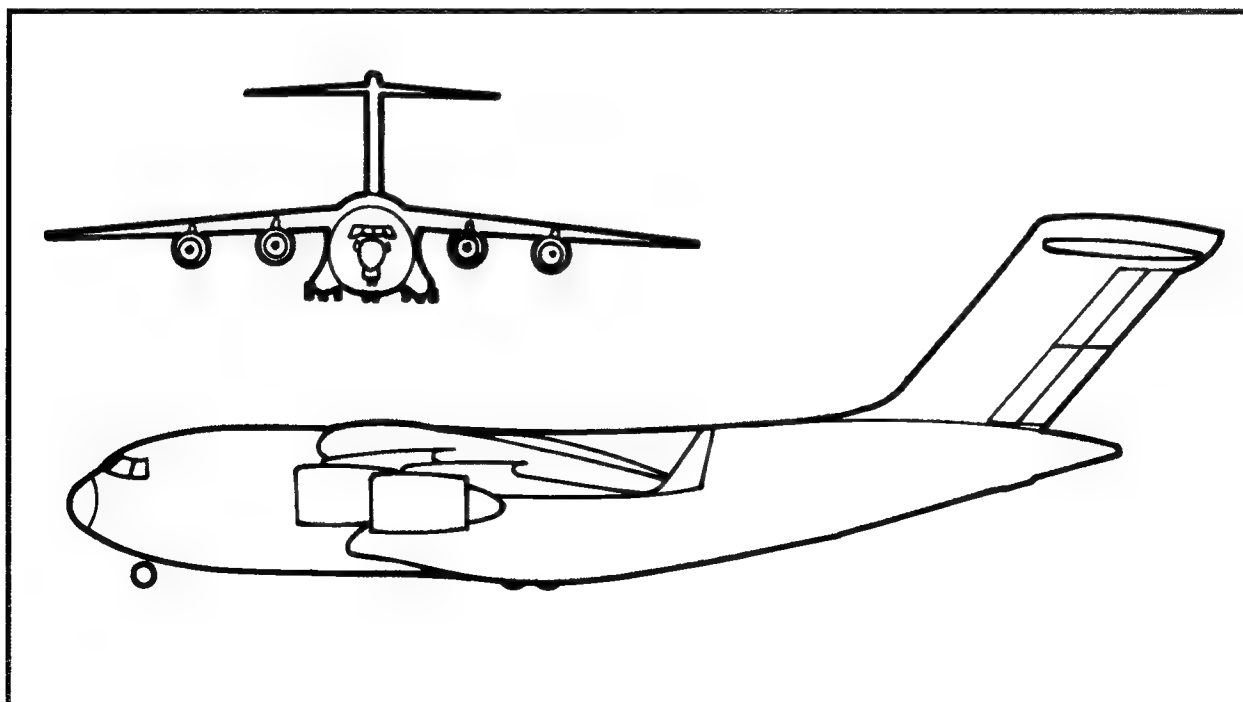
The maximum tandem-axle load allowed on the C-5 is 25,000 pounds per axle.



The maximum tracked vehicle weight for the C-5 is 129,000 pounds.



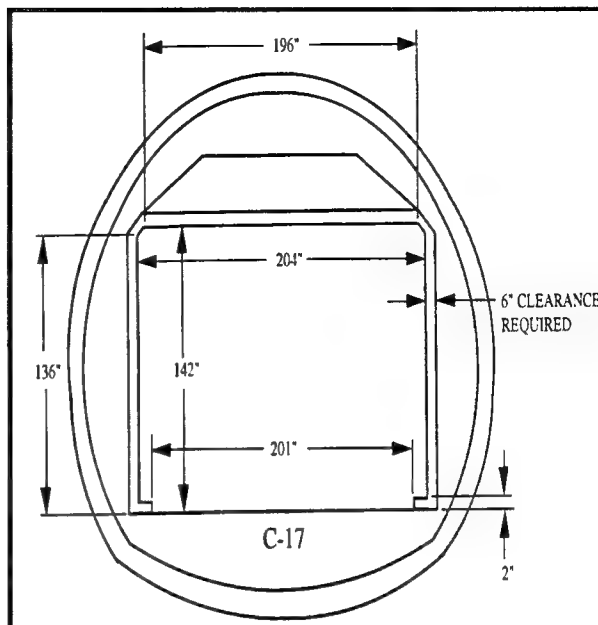
C-17



The C-17, a high-speed, high-capacity, long-range jet aircraft, can transport outsize and overweight cargo from origins in the United States to forward airfields overseas. Therefore, the C-17 can function as a strategic, intertheater aircraft and as a tactical intratheater aircraft. The C-17 is loaded through an aft cargo door.

The design limits for equipment to be transportable in the C-17 are:

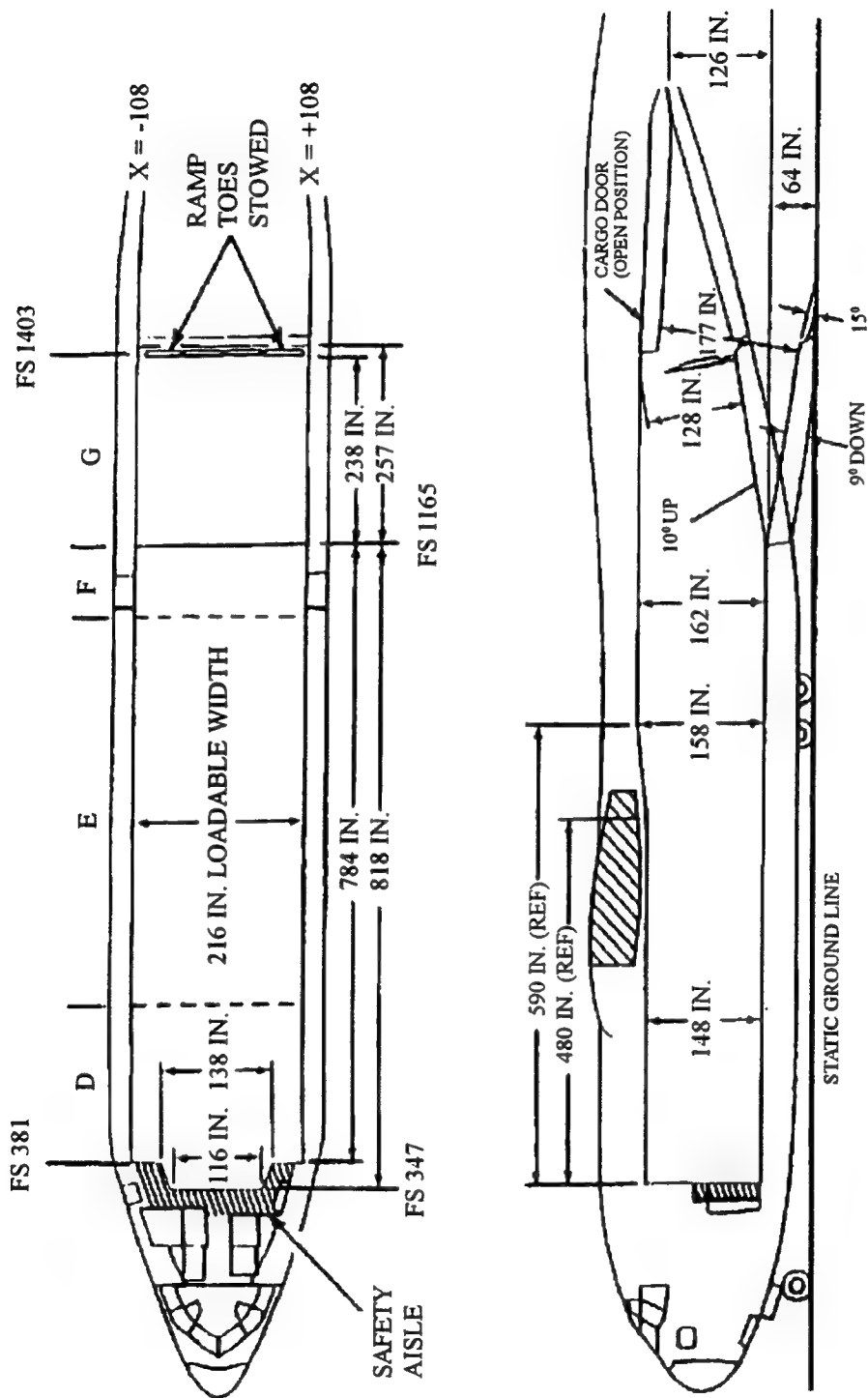
Height:	142 inches
Width:	196 inches (204 inches if height is less than 136 inches)
Length:	812 inches



These design limits allow for 6 inches of safety clearance between the equipment being loaded and the aircraft ceiling and side walls. The actual C-17 fuselage contours are shown in the following figures. The maximum payload of the C-17 will be about 170,000 pounds. A typical payload, allowing for fuel weight, is likely to be about 120,000 pounds. The C-17 design had not been frozen by September 1994, and some changes in the C-17 data listed here are possible. The C-17 cargo compartment width is designed for the side-by-side loading of two 96-inch-wide wheeled vehicles (such as 5-ton vans). Wheeled vehicles

should not exceed 96 inches in width to take full advantage of the capability of the C-17.

The maximum single axle load for pneumatic tires on the C-17 is 36,000 pounds. Single axle loads between 27,000 and 36,000 pounds are limited to a 41.25-foot portion of the aircraft (FS 578 to 1,073). The maximum tandem axle load is 40,000 pounds between FS 578 and FS 1,073. If the vehicle centerline is offset more than 8 inches from the aircraft centerline, then the maximum axle load is 27,000 pounds FS 578 to FS 1,073 and 22,000 pounds elsewhere. The maximum axle loads may be even lower if vehicles are loaded side by side.

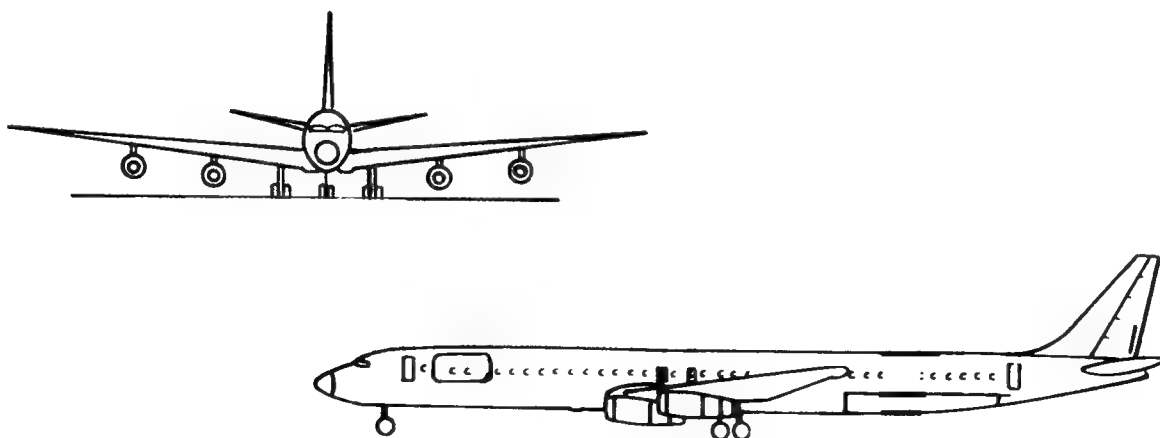


Note: These figures do not include the reduction for 6 inches of safety clearance.

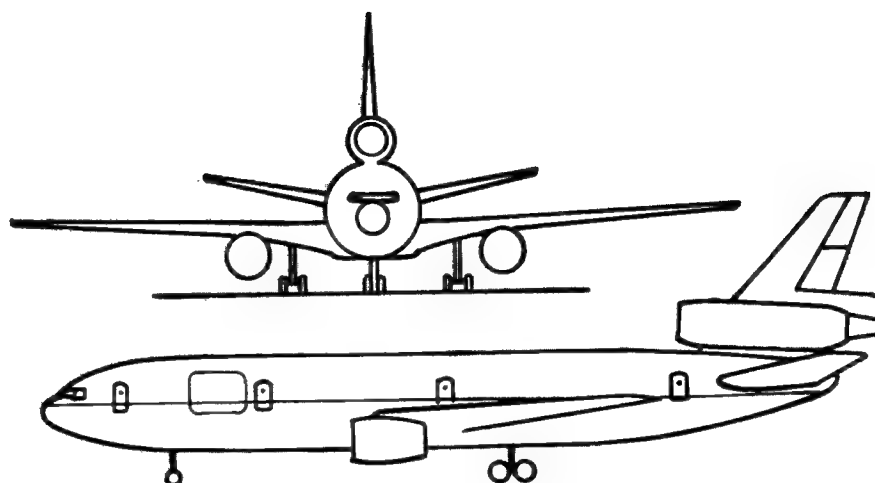
CIVIL RESERVE AIR FLEET (CRAF)

The Civil Reserve Air Fleet (CRAF) represents about 50 percent of the USAF total strategic wartime airlift capability. It consists of US civil air carriers that have contracted to provide support personnel, equipment, and aircraft to the USAF. The aircraft that make up the long-range international cargo portion of CRAF are the wide-body B-747 and DC-10 and the narrow-body DC-8. Unlike the standardized military cargo aircraft, civilian aircraft differ not only among carriers but also within the fleets of carriers. These variations make it very difficult to plan the design of military equipment for CRAF transport. CRAF aircraft will transport some military vehicles, but most CRAF aircraft will transport personnel and palletized cargo.

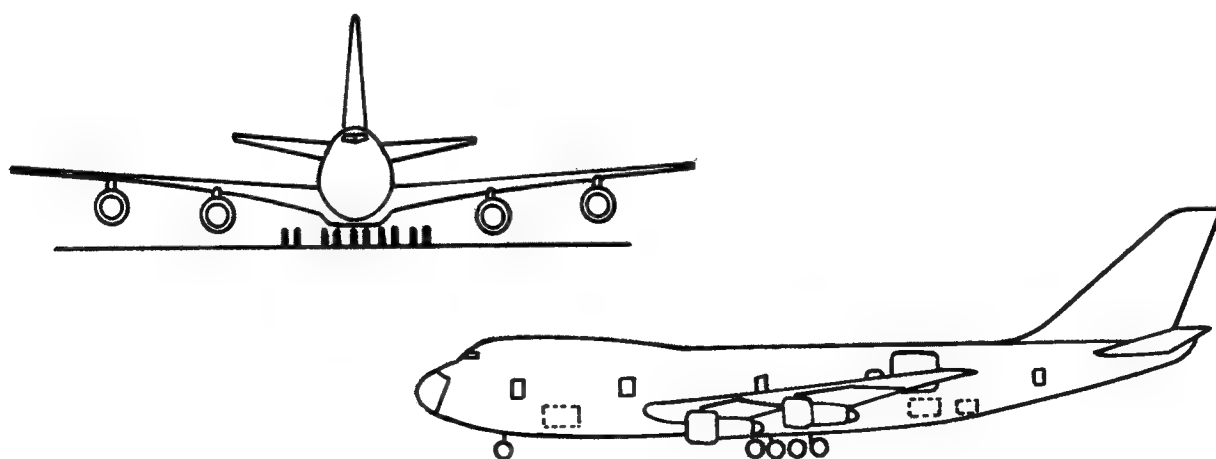
DC-8



DC-10



B-747



AIRDROP

Airdrop is used to support two types of military operations: mass assault and resupply. In a mass assault operation, a large quantity of personnel, supplies, and equipment are airdropped into the opposing forces' territory to establish a position. In a resupply operation, items such as rations, equipment, ammunition, water, fuel, and medical supplies are airdropped into an area held by friendly forces to replenish dwindling stocks. (This procedure takes place when aircraft landing is impossible.) When possible, items should be airdropped in their operational configurations.

The C-130 and C-141 are the primary USAF aircraft used for low-velocity airdrop. The C-5 is available but limited, for now, to a small number of aircraft. The C-17's airdrop capability exceeds that of the other aircraft.

Before heavy vehicles or equipment are airdropped, each item is secured to an airdrop platform. Energy-dissipating material is placed between the item and the airdrop platform to absorb the impact shock when the platform strikes the ground. The dimensional limits of a rigged

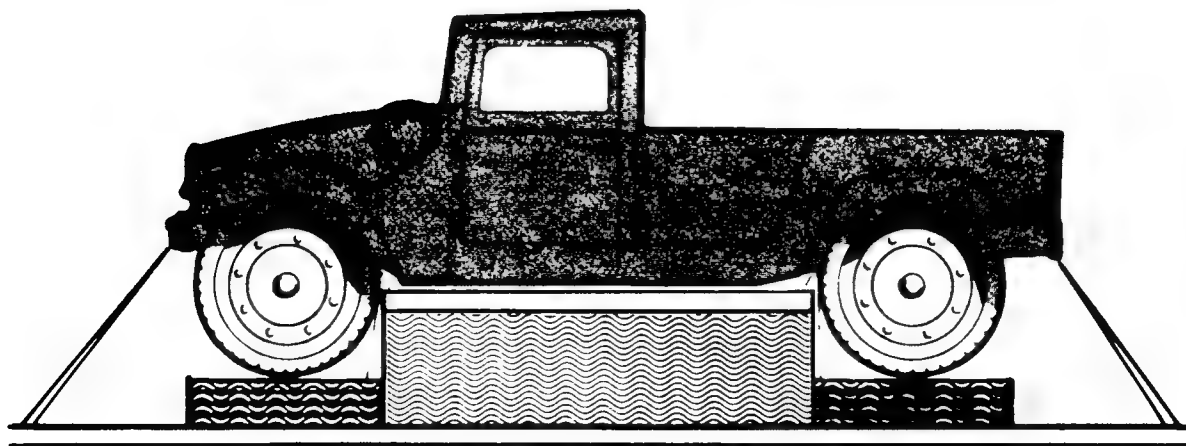
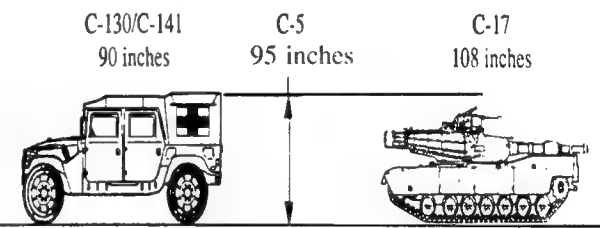
load (airdrop platform, energy-dissipating material, and the item to be airdropped) are:

	<i>C-130/ C-141 (in.)</i>	<i>C-5 (in.)</i>	<i>C-17 (in.)</i>
Height*:	100	105	118
Width:	108	108	126

*The height is further restricted forward of the rigged item's center of gravity to allow extraction under a malfunction condition.

The maximum airdrop height for vehicles with rubber tires and vehicles with suspension systems is:

C-130/C-141	90 inches
C-5	95 inches
C-17	108 inches



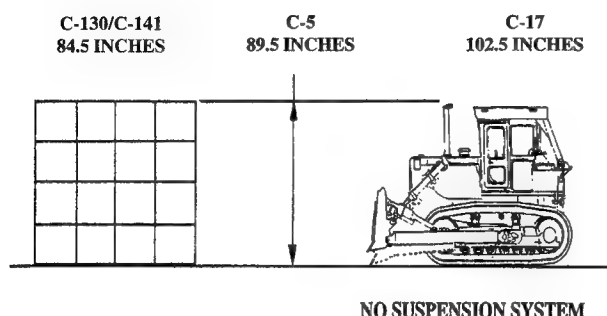
The maximum airdrop height for all other equipment is:

C-130/C-141	84.5 inches
C-5	89.5 inches
C-17	102.5 inches

*May be increased to 42,000 pounds for the C-141 during contingencies (wartime) with USAF approval.

**The C-5 is undergoing operational testing for 60,000-pound airdrop.

***This is a C-17 system requirement, but it has not yet been tested.



The maximum gross rigged weight (GRW) of an item to be airdropped is estimated based on the following formula:

$GRW = 1,600 \text{ pounds} + (1.18 \times \text{item weight for airdrop})$

The maximum airdrop weights (in pounds) for fully rigged loads are:

C-130	C-141	C-5	C-17
42,000	38,500*	42,000**	60,000***

The maximum item weights for airdrop, which depend on the rigging requirements, are about 34,200 pounds for the C-130, 31,270 for the C-141, 34,200 for the C-5, and 49,500 for the C-17.

LOW ALTITUDE PARACHUTE EXTRACTION SYSTEM (LAPES)

LAPES is a type of airdrop used for platform loads in which loads are extracted from C-130 aircraft at extremely low altitudes, from 5 to 15 feet. After extraction, the load strikes the ground and slides to a stop. The C-17 is also capable of LAPES operations.

The maximum item weights for LAPES, which depend on the rigging requirements, are 37,600 pounds for the C-130 and 54,760 pounds for the C-17.

The maximum gross rigged weight of an item for LAPES can be estimated from the following formula:

$\text{Gross rigged weight} = 2,500 \text{ pounds} + (1.05 \times \text{item weight for LAPES})$

Sources: **MIL-STD-1791**, *Designing for Internal Aerial Delivery in Fixed Wing Aircraft*, and **MIL-STD-814**, *Requirements for Tiedown, Suspension, and Extraction Provisions on Military Materiel for Airdrop*.

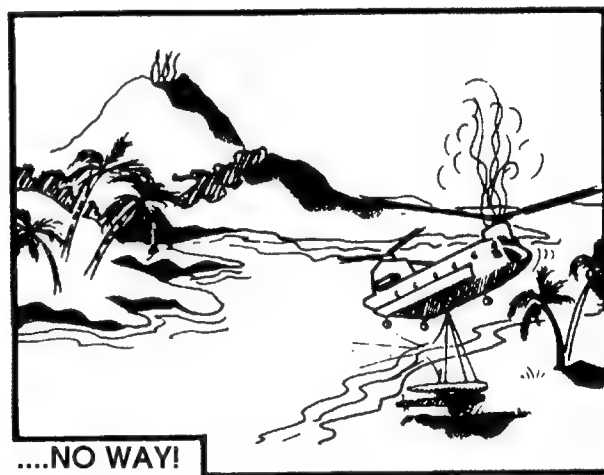
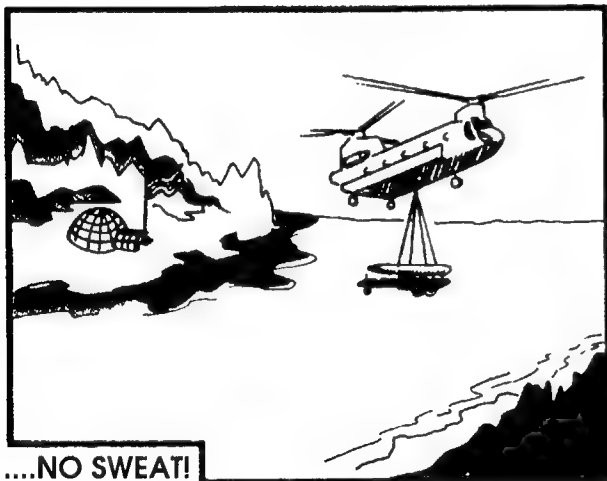
AIR (ROTARY WING)

Rotary wing aircraft are used mainly for short-range, tactical transport missions. These aircraft have the ability to transport essential equipment directly to a forward area without having to contend with en route terrain obstacles or damaged road or railroad systems. The five common types of military helicopters that are used to transport cargo are the UH-1 and UH-60 utility helicopters and the CH-46, CH-47, and CH-53 cargo helicopters. All five types of helicopters are capable of external lift operations. The CH-47 and CH-53, however, are the only

helicopters with cargo compartments large enough to carry a significant amount of cargo.

Each helicopter has a maximum payload rating; however, the lift capability and range of each helicopter differ for each mission. The temperature, altitude, and fuel carried in a helicopter must be considered for each mission.

Helicopters can rarely fly at their maximum payload rating. If a requirement exists for helicopter lift, the mission (weight and distance) requirements must be known.



The maximum external loads (pounds) that can be lifted by some common helicopters appear in the table on the right.

Mission Scenario	UH-1H	UH-60A	CH-46E	CH-47D	CH-53D	CH-53E
Sea Level, 60 F, 30 Nautical Miles (NM)	2,550	7,850	5,915	25,150	14,693	34,771
2,000 ft, 70 F, 30 NM	2,600	7,350	5,481	23,200	13,891	28,298
4,000 ft, 95 F, 30 NM	1,150	4,750	3,783	16,450	7,860	18,177

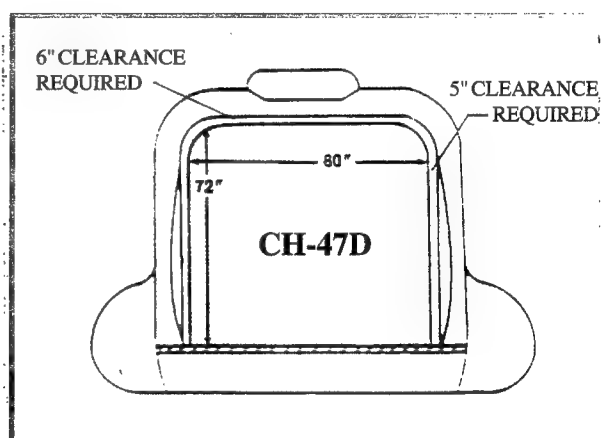
Note the dramatic decrease in helicopter payload capability with increasing temperature and altitude! Also, the CH/MH-53 has wide variations in capability depending on the precise model. Other CH/MH-53 models have different capabilities.

variations in capability depending upon the precise model. Other CH/MH-53 models have different capabilities. You can find payload capacities for other helicopters in MIL-STD-1366C.

All vehicles that require CH-47 and/or CH-53 internal transport must be capable of roll-on/roll-off loading and unloading in the operational configuration.

The dimensional design limits for equipment to be internally transported by the CH-47 are:

Height: 72 inches
Width: 80 inches
Length: 331 inches



These design limits allow for safety clearances of 6 inches between the equipment and the aircraft ceiling and 5 inches at the sidewalls.

The maximum internal loads (pounds) that can be lifted by some common helicopters appear in the table on the right. Internal helicopter payload capability can decrease significantly with increasing temperature and altitude. Also, the CH/MH-53 models has wide

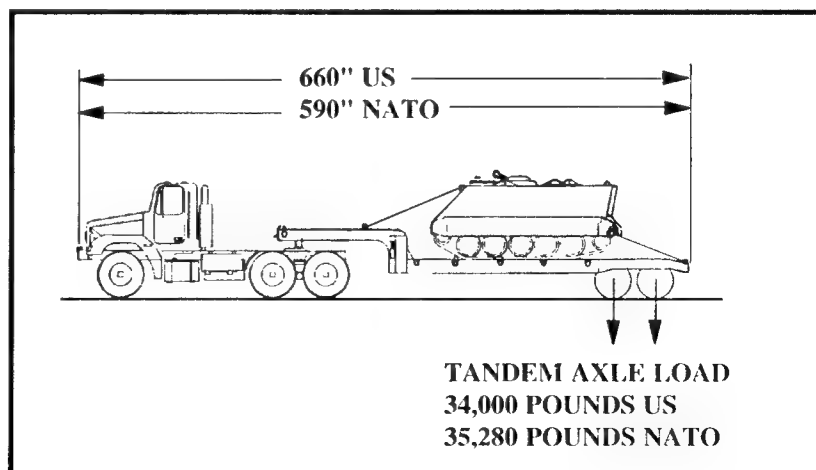
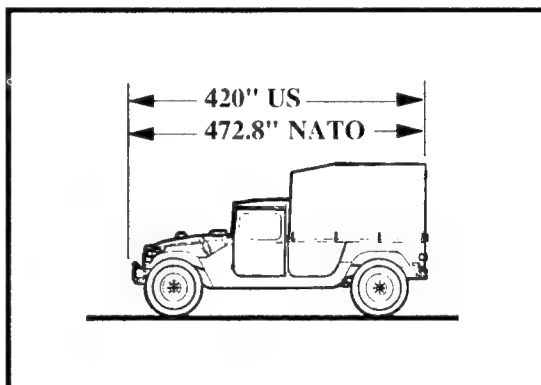
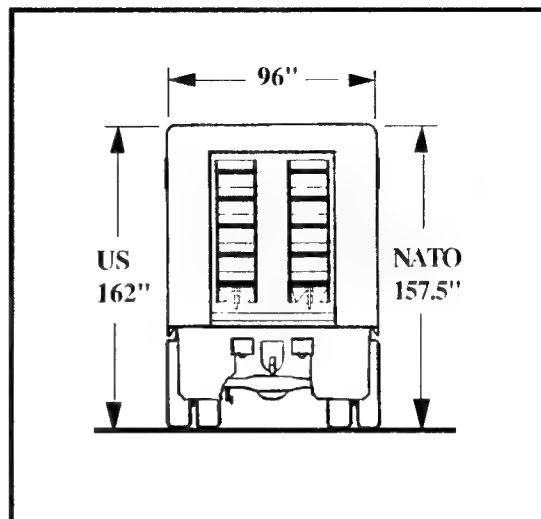
Mission Scenario	CH-46E	CH-47D	CH-53D	CH-53E
Sea Level, 60 F, 30 Nautical Miles (NM)	6,026	23,300	14,768	34,986
2,000 ft, 70 F, 30 NM	5,596	23,350	13,972	28,600
4,000 ft, 95 F, 30 NM	3,886	16,900	7,910	18,591

HIGHWAY

GENERAL

Highway is the most common transport mode. It is essential for both strategic and tactical deployment, as well as day-to-day operations. Military equipment usually is not located at its strategic deployment port of embarkation, such as ports or airfields. Highway transport can be used to reach these points of embarkation especially if they are less than 400 miles from the origin of the deployment. For tactical deployment, this mode allows the item to be delivered as close as possible to the point where it is needed. This mode is also the most flexible of the surface transport modes. Maximizing the efficiency of the highway network requires that vehicles and vehicular combinations be capable of unrestricted movement. This movement is possible if vehicles or vehicular combinations do not exceed legal size and weight limits imposed by States and foreign countries. If the dimensional and weight limits shown in the figures are not exceeded, movement will be unrestricted in most States and NATO countries.

The gross vehicle weight limit depends on the number and spacing of axles of the vehicle. Each State highway authority sets its own oversize/overweight limits. As a general guide, the gross vehicle weight limit for the United States is 80,000 pounds. More detailed information is available in the American Trucking Association's highway size and weight limits chart.

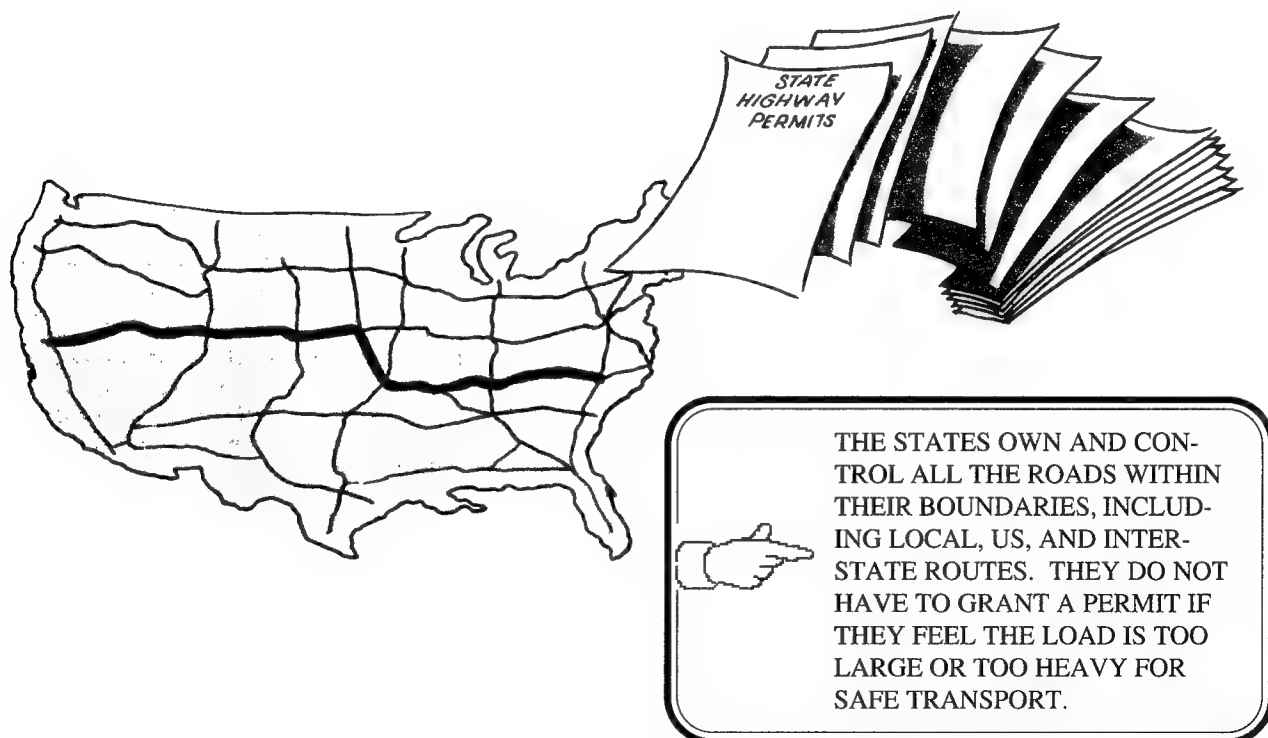


HIGHWAY PERMITS

Vehicles and vehicular combinations that exceed the legal highway limits will require permits for highway transport. The difficulty in obtaining these permits depends on the amount that the legal limit is exceeded. Circuitous routing, resulting in transport delays, may be required as a condition of the permit. Permits for vehicles that exceed the legal width and length limits are not as difficult to obtain as those for vehicles that exceed the legal height and weight limits. In general, States will not issue permits for reducible or divisible loads. **AR 55-162/OPNAVINST**

4600.11D/AFR 75-24/MCO 4643.5C/DLAR 4540.8, *Permits for Oversize, Overweight, or Other Special Military Movements on Public Highways in the United States*, explains the procedures for obtaining highway permits.

Many States are reluctant to grant permits for overweight cargo vehicles with divisible loads, since these vehicles can be brought within normal legal limits simply by reducing the payload. In some cases, a vehicle with a high empty weight may have a very limited legal payload.



CERTIFICATION AS ESSENTIAL TO NATIONAL DEFENSE

If a shipment exceeds State permit limits, the only recourse left for highway transport would be to declare the shipment as essential to national defense. The following requirements must be met for an item to be certified as essential to national defense:

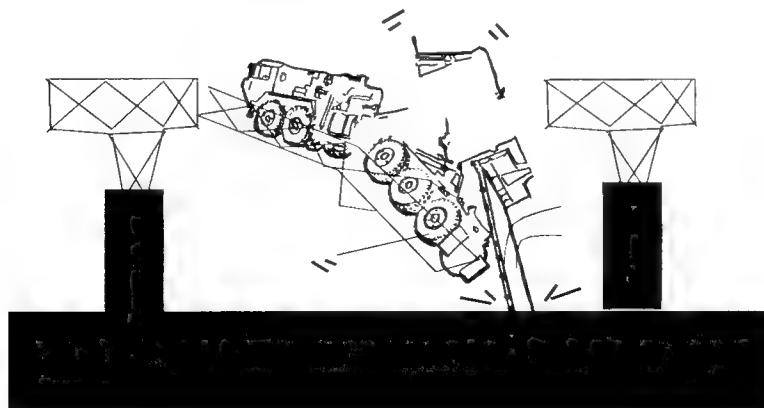
- The item must be essential to mission completion or unit readiness.
- The item cannot be reduced or moved by commercial transporters to conform with the limits.
- There is no alternative to highway transport.

A move should be certified before its permit application is filed, not as an afterthought to override a permit denial. Movement for routine training, maintenance, or equipment displays will not be considered essential to national defense. If all these requirements are met, the commander of the transporting installation will request the major commander of the shipping activity to certify the shipment as essential to national defense. The local installation commander cannot certify a shipment as essential to national defense. The *Directory of Highway Permit Officials and*

Mobilization Movement Control (MOBCON) Coordinators, published by MTMCTEA, lists the individuals authorized to determine essentiality to the national defense. It also lists military officials authorized to request, and State officials authorized to grant, permits for oversize, overweight, or other special military movements on public highways.

Only a major commander can declare a shipment essential to national defense. Certification as essential to national defense is not a guarantee that State highway officials will allow the shipment. The States have complete authority over their highway network, and their determination is final.

Pavement and structures have a practical limit. Certification as essential to national defense, followed by the State's permission, does not ensure the load can be transported safely and without damage to the roadway. Pavement and structure analysis may be required at DOD's expense before transporting extremely heavy items. If roadways are damaged, DOD must reimburse the State for the cost to repair the damages.



RAIL

Rail transport is essential for the shipment and deployment of oversize and overweight equipment. It is also essential for the land deployment of all equipment transported farther than 400 miles. When many items are to be shipped, rail transport is often cheaper than highway transport.

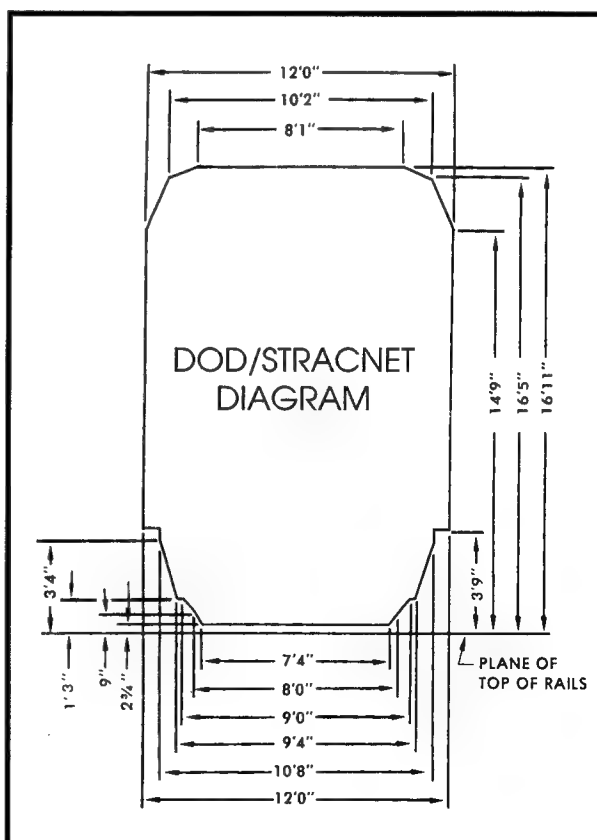
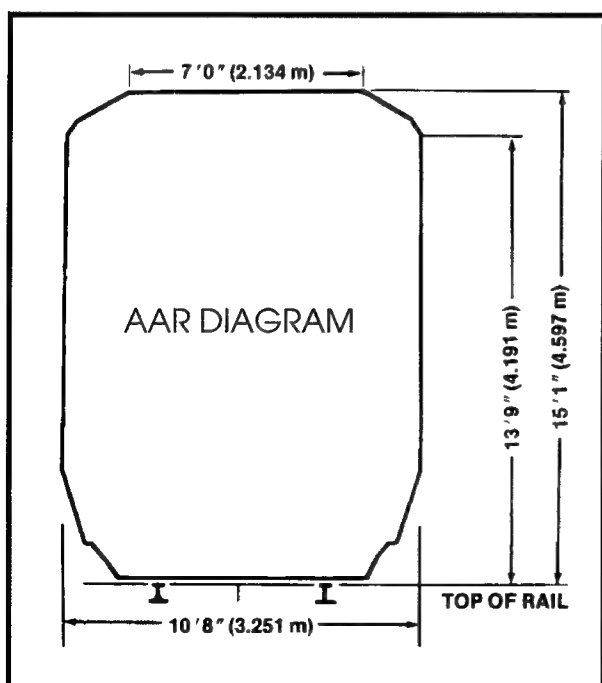
Rail transport of tactical vehicles reduces the time the vehicles must operate during deployment and, thus, places them on the front lines in top operational condition. Rail transport reduces wear and tear on tactical vehicles, minimizes the requirements for en route support, and reduces maintenance requirements.

Although oversize and overweight equipment is routinely transported by rail, there are still maximum limits and restrictions to rail transport. These restrictions are given in clearance diagrams or published in rail line clearances. When railcar-mounted equipment exceeds the clearance diagrams, it probably could be transported

by rail but would require special routing and special provisions.

Rail transport on standard-gauge rail lines in North America and in Europe is more important than rail transport in other areas of the world to military planners, because military equipment is predominant and the rail network is extensive in these areas. Korea also has a standard-gauge rail network. The five rail clearance diagrams of greatest interest are:

North America: Association of American Railroads (AAR) outline diagram for single loads, without end overhang, on open-top cars
DOD clearance profile for the Strategic Rail Corridor Network (STRACNET)

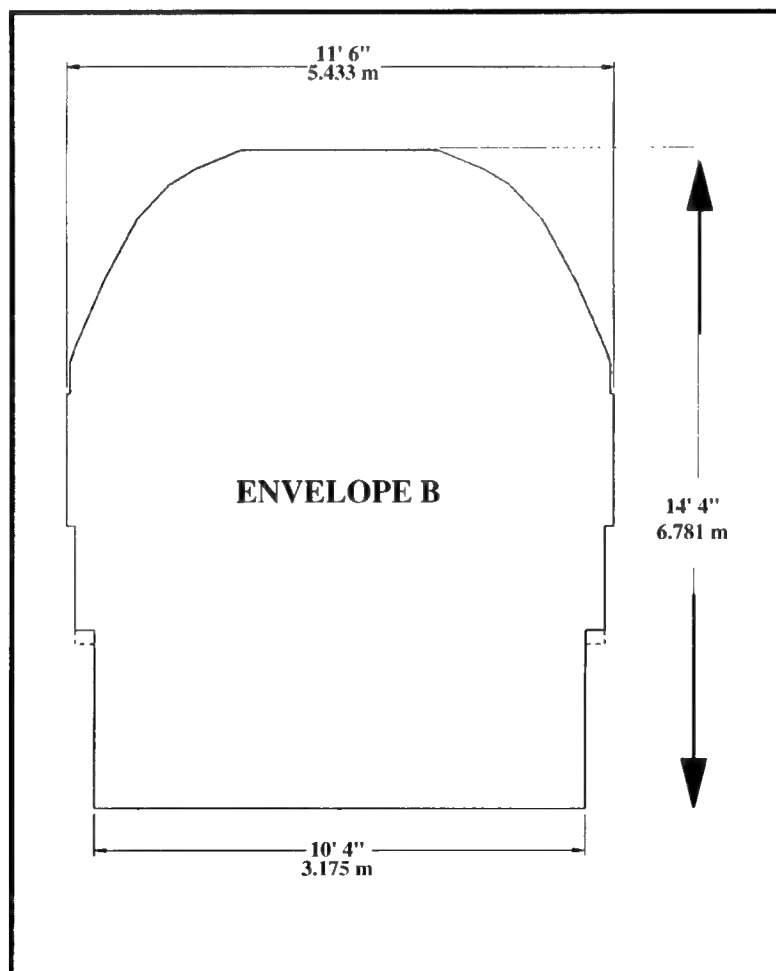
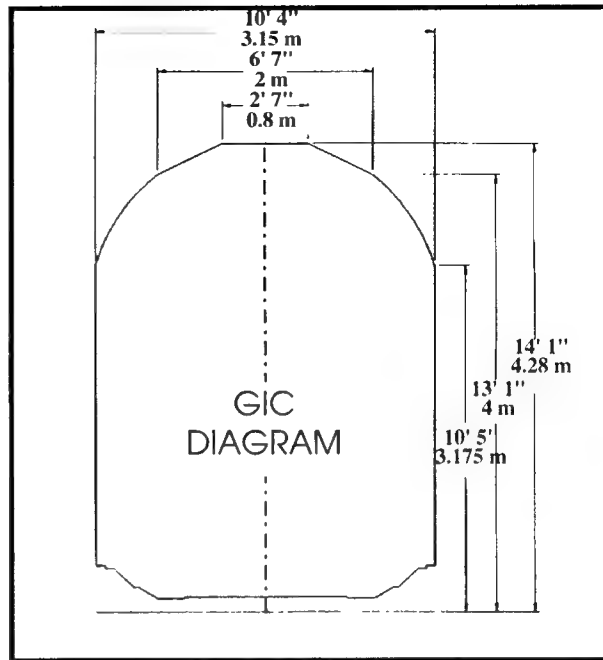


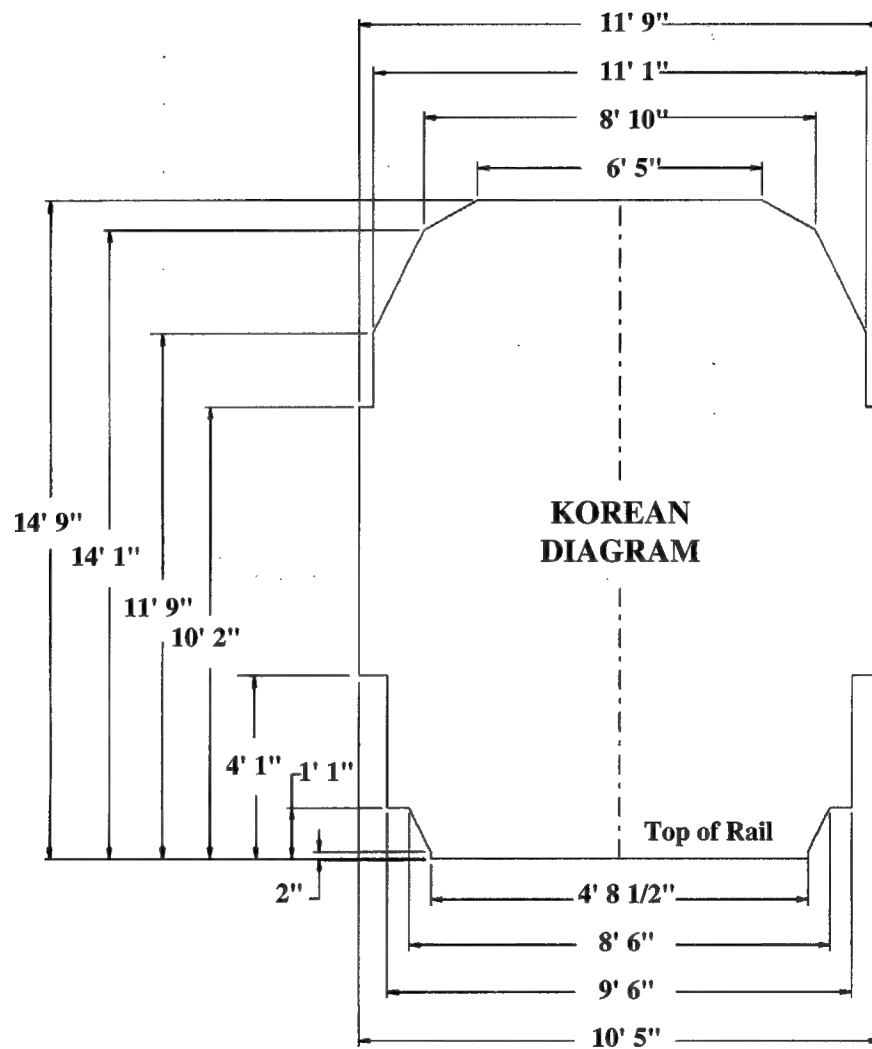
Europe: Gabarit International de
Chargement (GIC)
Envelope B

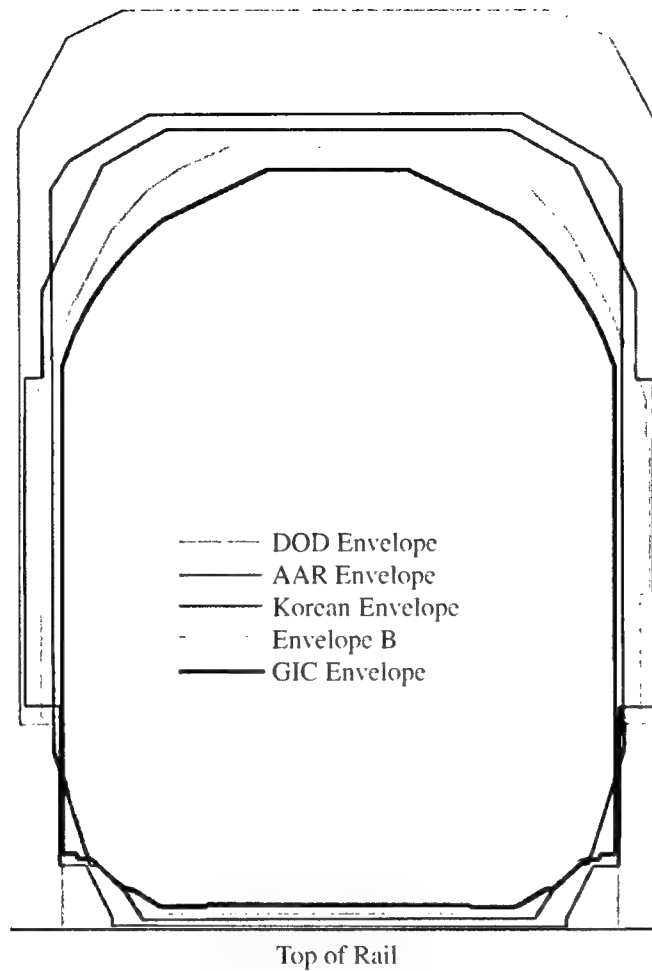
Korea: Korean clearance diagram

The AAR diagram applies to rail lines in North America. Equipment that is mounted on 50-inch-high railcars and falls within the limitations of the AAR diagram will be capable of unrestricted movement on almost all rail lines.

The DOD STRACNET clearance profile accommodates 86 percent of DOD types of equipment and 99 percent of individual pieces of equipment in the DOD inventory. However, it is only valid







for selected routes and sometimes only at severely restricted speeds. Other special conditions may also apply.

The GIC equipment gauge (formerly the PPI) applies to rail lines in European countries. Equipment that is mounted on 50-inch-high railcars and falls within the limitations of the GIC gauge will be capable of essentially unrestricted movement worldwide on standard-gauge rail lines.

Equipment Envelope B applies to rail lines in NATO countries on the European continent. The equipment Envelope B rail network is not as extensive as the GIC equipment network.

If equipment exceeds the clearance diagrams, it still may be transported by rail; however, special routing and provisions may be required. This special treatment will add to the transport time - a luxury not available when rapid deployment is essential.

Rail transport can subject equipment to the greatest longitudinal shock loads of any transport mode, especially during rail humping. Rail humping is a procedure used in rail classification yards to assemble separate railcars into trains. A railcar is pushed over a hump and is allowed to roll into and couple with the train being assembled. During coupling, the normal speed is usually under 4 mph, but speeds can go as high as 8 mph.

WATER

Water transport is used for both strategic and tactical deployments. During strategic deployment, most military equipment will be transported by ship. The types of ships that will be used include breakbulk (general cargo), container, roll-on/roll-off (RORO), and barge-carrying (LASH and SEABEE) ships. In general, almost all items of equipment can be transported by ship without major problems or restrictions. However, the equipment must have good, accessible lifting provisions. Equipment too heavy for

lift by shipboard cranes requires dockside cranes. Such equipment is also limited to improved ports. Equipment to be delivered to unimproved ports or underdeveloped areas must be light enough to be lifted by shipboard cranes. Lighters are listed in the table below. They are essential in logistics-over-the-shore (LOTS) operations.

SOURCES: **MIL-STD-1366C**, *Transportability Criteria*, and *US Army Aviation and Troop Command*

US MILITARY LIGHTERAGE

	Normal Cargo Capacity (lb)*
LCM-6 (Landing Craft, Mechanized)	68,000
LARC-LX (Lighter, Amphibious, Resupply, Cargo)**	120,000
LCM-8 (Army and Navy/USMC)	120,000
LCAC (Landing Craft, Air Cushioned)	***120,000
LCU-1646 (Army)	358,400
LCU-1646 (Navy/USMC)	400,000
LCU-2000 (Landing Craft, Utility)	700,000
Logistics Support Vessel (LSV)	4,032,000
*For some lighters, it is possible to exceed these weight limits under certain restricted circumstances.	
**LARC-LX has the same payload capability as the LCM-8, but the cargo area is slightly smaller. In general, requirements documents should require items to be marine transportable on the LARC-LX and larger vessels.	
***Overload capacity is 150,000 pounds.	

CONTAINERS AND SHELTERS

Cargo containers are transport equipment designed and constructed to facilitate the international and intermodal exchange of goods. They are designed to be used repeatedly and to provide security during transport. Also, their fittings readily permit handling and transfer from one transport mode to another. A very strong trend exists for commercial ocean carriers to equip their fleets predominately with ships that have standardized container cells and to withdraw breakbulk ships from service. Thus, force deployability will be improved if many pieces of individual military equipment can be containerized for movement in commercial container ships. Designing for container transport effectively increases the strategic sealift assets available for deploying the force.

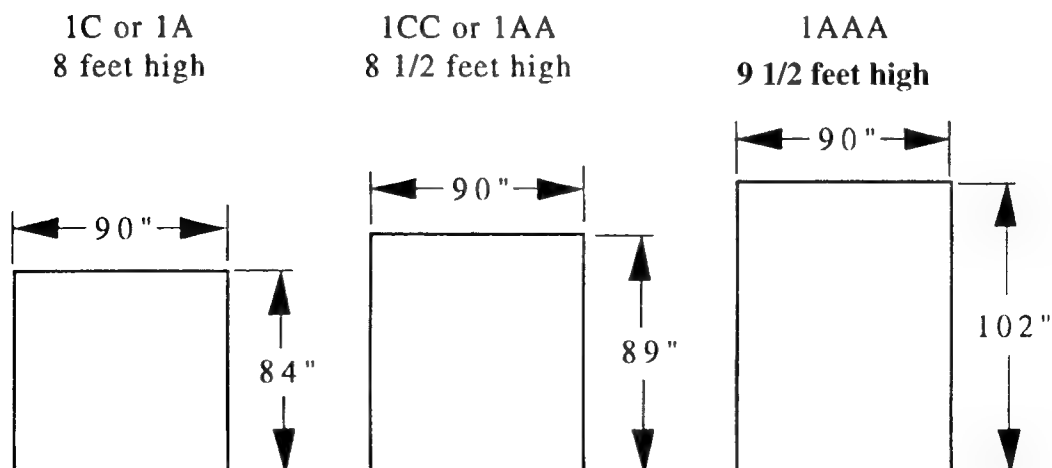
Military materiel should be transportable in 8.5-foot-high by 8-foot-wide by 20-foot-long American National Standards Institute/International Organization for Standardization (ANSI/ISO) containers, where practical, to take full advantage of the intermodal benefits of containerization. Other common containers for military

transport are the ANSI/ISO 9-foot-6-inch-tall containers and the ANSI/ISO 40-foot-long containers.

For rail, truck, and ocean transport, a 20-foot container is limited to a gross weight of 52,900 pounds and a 40-foot container, to a gross weight of 67,200 pounds. For air transport, lower maximum weights apply. The weight of the containers alone is generally less than 6,000 and 9,000 pounds for 20- and 40-foot containers, respectively.

The door openings of 8-foot-high ANSI/ISO containers are 90 inches wide and 84 inches high. The door openings of 8-1/2-foot-high ANSI/ISO containers are 90 inches wide and 89 inches high. Interior widths and heights are subject to slight variations, but are always larger than the door openings. Items being designed for containerization should be no more than 85 inches wide and no more than 85 inches high (80 inches high if designed for 8-foot high containers and MILVANS.) Commercial 8-1/2-foot-high ANSI/ISO containers are now so common that, if

ISO Container Door Openings



military equipment fits within them, it will be readily container transportable, at least on the ocean leg of its journey. The interior lengths of 20- and 40-foot containers are at least 231 and 472 inches, respectively.

Many communications, support, and weapons systems require the use of shelters. When shelters are used, they should be made the same size and equipped with the same fittings as ANSI/ISO containers, or standard shelters such as the S-250, S-280, Standardized Integrated Command Post System (SICPS), or S-788 Lightweight Multipurpose Shelter (LMS) should be used. ***The use of nonstandard shelters should be avoided!*** Developers must take care not to overload shelters and complete systems. As the

following table shows, overloading a system prime mover is possible even if the maximum theoretical shelter payload is not exceeded. When calculating shelter weight, do not forget to include basic issue items (BII), camouflage nets, ladders, manuals, cable reels, and any other items that will be carried on the shelters.

SOURCES: MIL-STD-1366C, *Transportability Criteria*; **MIL-STD-910**, *Mobile Tactical Systems Overload Prevention Procedures*; and **ISO 1496/1**, *Series 1 Freight Containers*, and **US Army Natick Research Development and Engineering Center**.

ALLOWABLE SHELTER PAYLOADS (1b) ON DIFFERENT PRIME MOVERS

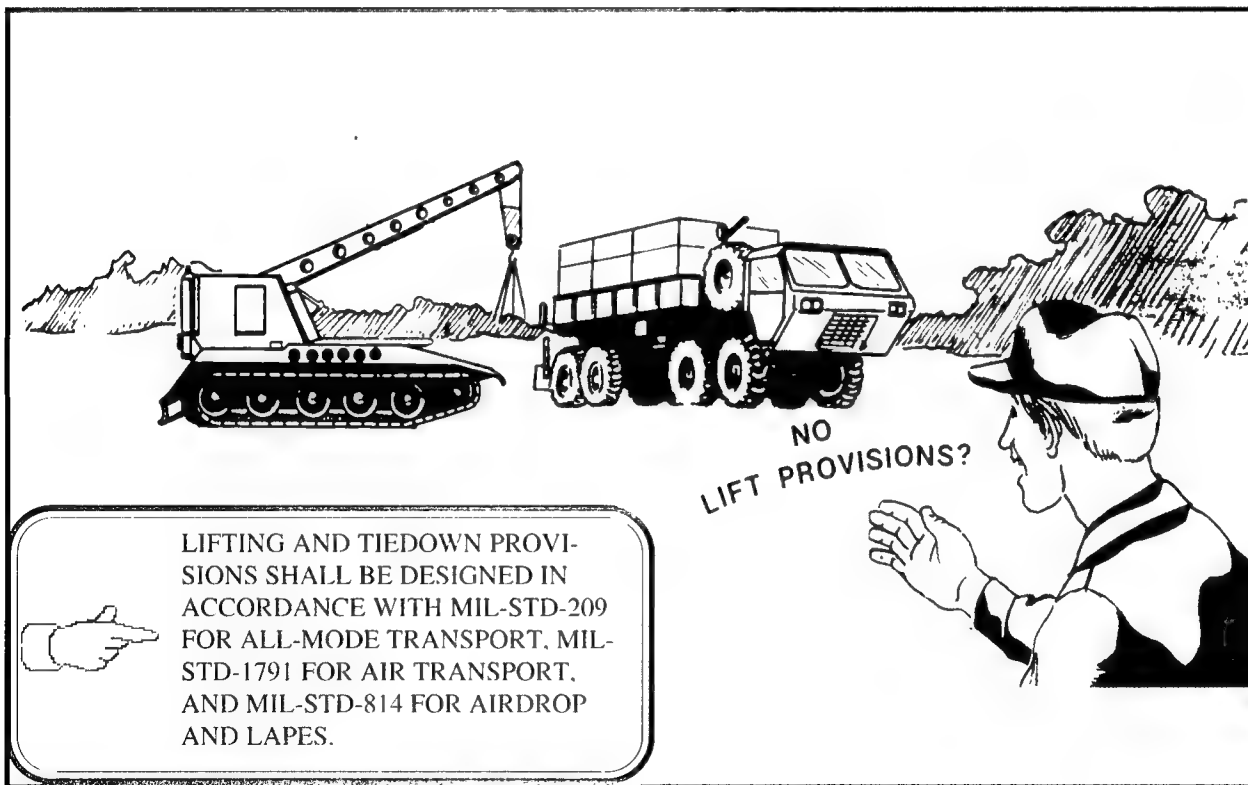
Shelter	Alone	Prime Movers					
		(1) HMMWV M1037	(1) Heavy HMMWV M1097	CUCV(2) M1028A1	CUCV(2) M1028A2 M1028A3	2.5-Ton Truck	5-Ton Truck
S-250 (3)	2,530	1,758	2,530	2,000	2,400	2,530	2,530
LMS (Type I)							
S-788 (4)	3,300	1,922	3,146	2,534	2,934	3,300	3,300
S-280b (5)	5,000	(6)	(6)	(6)	(6)	3,600	5,000
S-280 (5)	7,100	(6)	(6)	(6)	(6)	3,600	7,100
<p>(1) 2-man crew and gear at 566 lb deducted from M1037 and M1097. However, if the HMMWV pulls a trailer, the pintle load must be deducted from the above figures.</p> <p>(2) 3-man crew and gear at 828 lb deducted from all M1028-series vehicles. However, if the CUCV pulls a trailer and the pintle load exceeds 200 lb, the shelter payloads will decrease.</p> <p>(3) Payloads shown are unshielded; for EMI shielding, deduct 12 lb from these payloads.</p> <p>(4) Based on estimated weight of 688 lb, which includes mounting kit.</p> <p>(5) Payloads shown are unshielded; for EMI shielding, deduct 10 lb from these payloads.</p> <p>(6) Shelter incompatible with vehicle or would overload it empty.</p>							

LIFTING AND TIEDOWN PROVISIONS

ADEQUATE LIFTING AND TIEDOWN PROVISIONS ARE ESSENTIAL TO EFFICIENT TRANSPORT. Equipment without adequate provisions is a logistic burden during deployment, especially when time is critical. Inadequate designs create restraint and handling problems during transport, especially transport by rail and marine modes. In addition, inadequate

designs can cause damage to equipment and be dangerous to personnel.

All items of military equipment must have adequately designed lifting and tiedown provisions. Vehicles must have provisions designed for the gross vehicle weight (fully loaded vehicle) because vehicles are deployed with unit equipment in their cargo beds.



3. TRANSPORTABILITY IN THE ACQUISITION PROCESS

GENERAL

Transportability must be addressed throughout the acquisition process. This chapter provides a discussion of how and where transportability fits into the acquisition process.

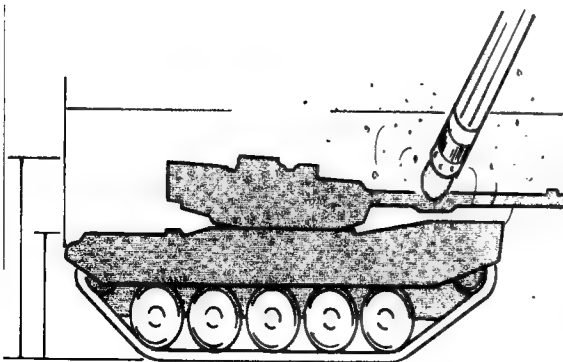
Transportability is important throughout the acquisition process; however, it is essential that transportability be considered at the beginning, when its impact on design is greatest. At this time, conceptual designs can best be altered to ensure the design conforms to the transportabil-

ity requirements. Any delay will result in lost time and increased costs if the equipment must be altered.

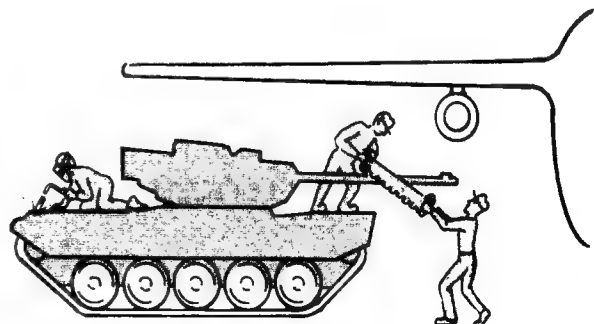


IT IS MUCH EASIER (AND CHEAPER) TO CHANGE A CONCEPT DRAWING THAN TO RE-DESIGN A PIECE OF EQUIPMENT.

CONFIRM TRANSPORTABILITY
EARLY...



BEFORE IT'S TOO LATE!



CONCEPTUAL STUDIES

In today's environment of declining budgets and changing threats, there is an increased emphasis on conducting comprehensive analyses on new concepts and technologies before proceeding to the Concept Exploration and Definition phase of the acquisition cycle. Advancements in modeling and simulation (M&S) technology give program managers access to this analysis capability.

To ensure that strategic mobility requirements are addressed during technology and concept development, transportability and deployability must be addressed during this early analysis process.

With this in mind, MTMCTEA has developed modeling and simulation tools that will improve DOD's capability to address transportability and

deployability throughout the acquisition process. These analysis tools result in improved up-front analyses and give program managers and concept developers the ability to conduct multiple analyses on different concepts and technologies.

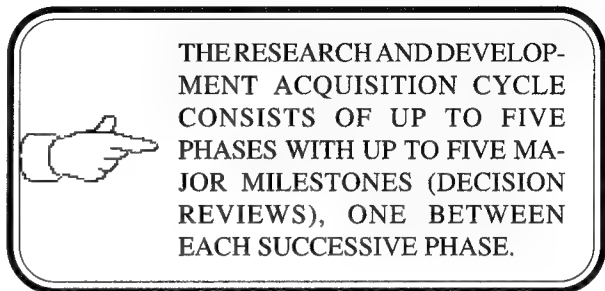
Program managers and concept developers should consult with MTMCTEA during technology base (Techbase) activities for transportability and deployability analysis support.

REMEMBER: If the new weapon system is to **DEFEAT the THREAT**, it must first get to **WHERE the threat is located**.

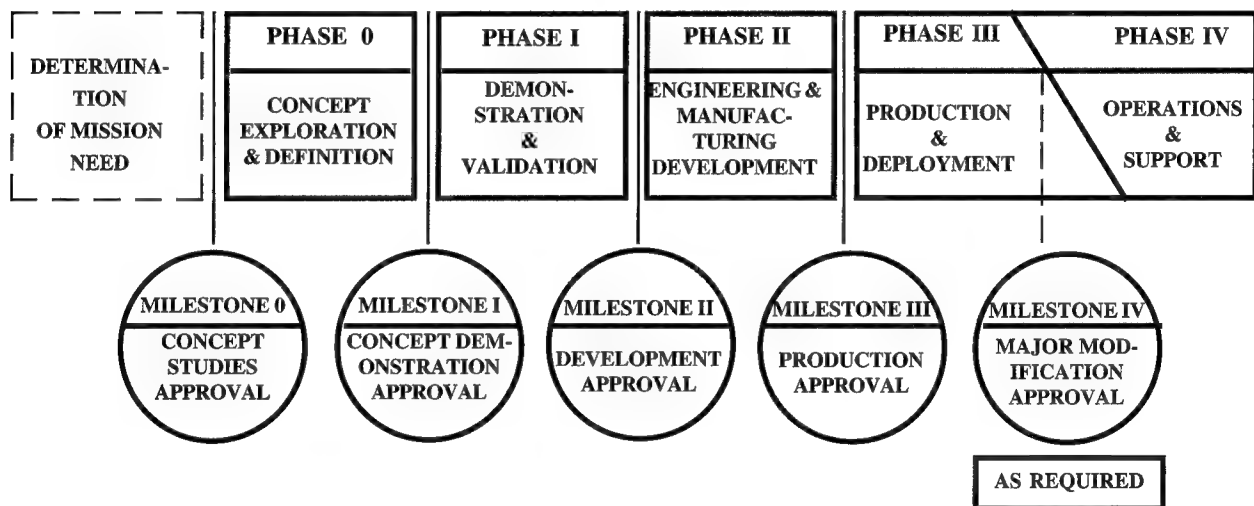
RESEARCH AND DEVELOPMENT ACQUISITION CYCLE

Transportability inputs to acquisition documents are made, and transportability actions (or events) take place throughout the Research and Development (R&D) acquisition cycle. Each input and action is important to assure that the equipment being procured, as well as the associated support items of the equipment, is capable of efficient transport. The omission of transportability in an acquisition document during the middle or later stages of the cycle can negate all transportability

efforts and advances made during the early stages of the cycle.



ACQUISITION MILESTONES AND PHASES



1. Determination of Mission Need

The acquisition process begins with the determination of mission need. Either a materiel or non-materiel (such as change to training, doctrine, or organization) solution might satisfy a mission need. At Milestone 0, the milestone decision authority (MDA) validates the need and determines that a materiel solution is necessary to satisfy the need. The Mission Need Statement (MNS) shall be the primary document for initiating a Milestone 0 review. The Mission Need Statement (MNS) will normally identify the required modes of transport (for example, "air"), but will *not* usually identify the actual transporters (such as "C-130"). The transportability section of a SAMPLE MNS could read as follows, "The [WEAPON SYSTEM] must be transportable by rail, highway, air, and marine modes. Helicopter external air transport (EAT) will be required. It must have military standard lifting and tiedown provisions."

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2. Phase 0, Concept Exploration and Definition

Once Milestone 0 has passed, the project moves to Phase 0, Concept Exploration and Definition. Once a materiel need has been established, **Combat** and **Materiel Developers** conduct preliminary concept studies to determine the direction in which the development effort should be concentrated.

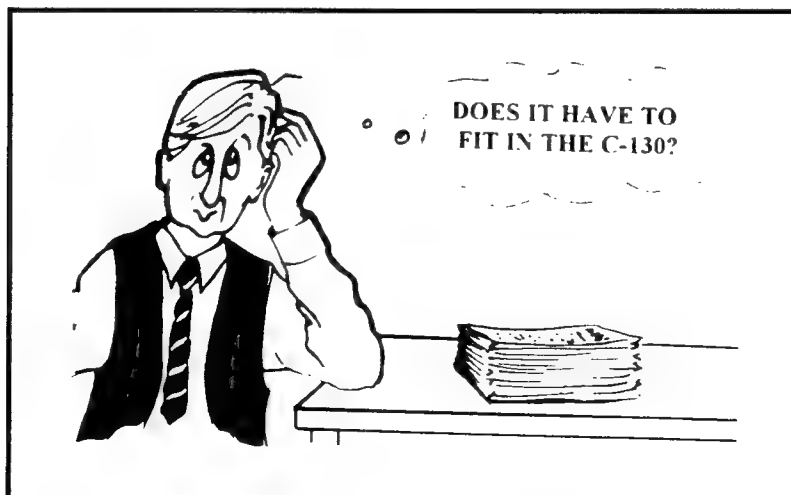
The best time to evaluate transportability is during these preliminary concept studies. At this time, any changes that are required to enhance transportability can be made with minimal effort and cost. If transportability is not adequately addressed at this time, the preliminary concept often becomes "set in concrete," and the time and expense to rectify transportability shortcomings greatly increase. The transportability of associated support items also should be addressed during the preliminary concept studies.

The risks associated with the concepts are to be defined during Phase 0. These risks may be operational in nature; however, significant risks can involve transportability. For example, a proposed concept for a weapon system may be so

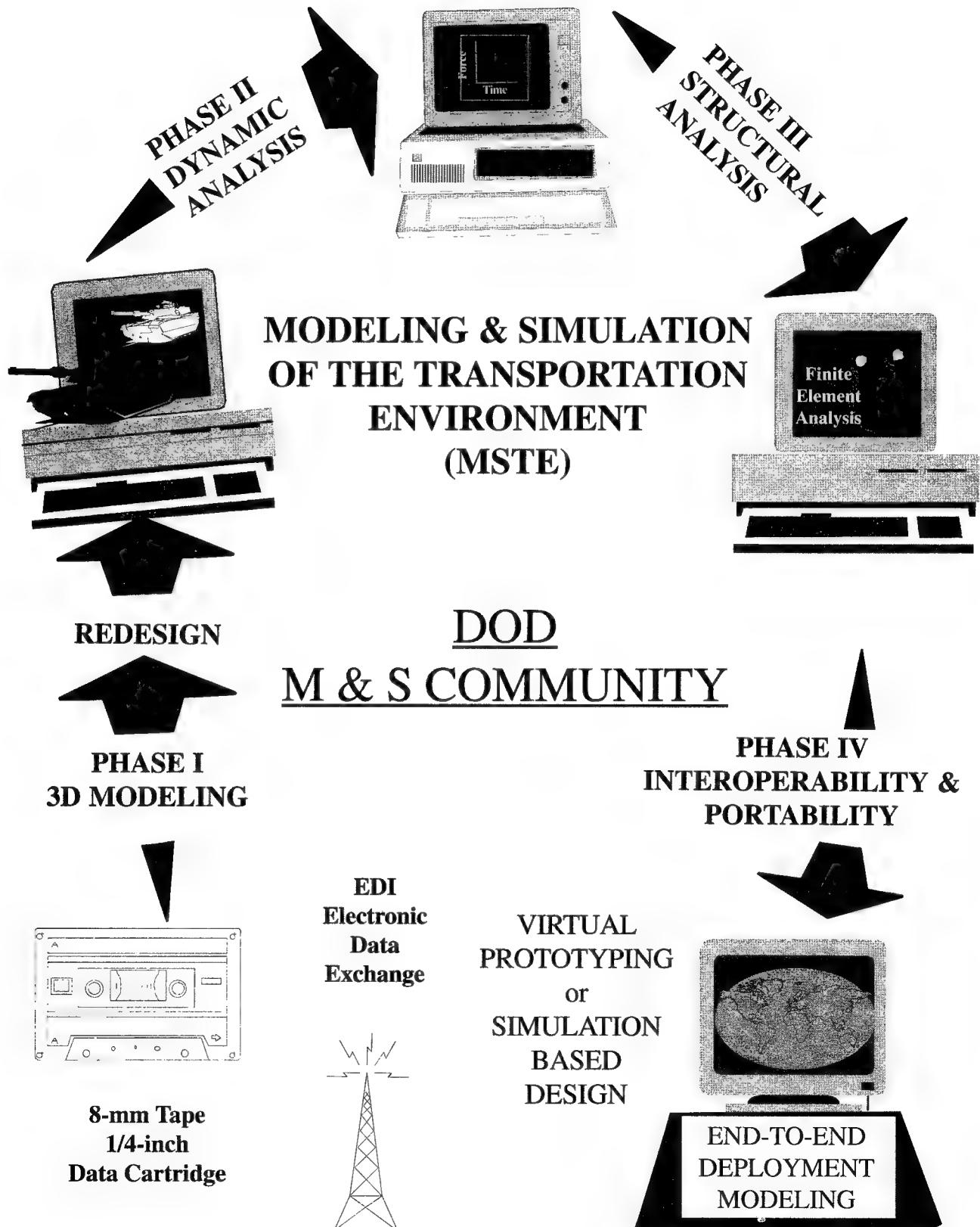
large that C-130, or even C-5, transport is far from assured. During Phase 0, specific exit criteria for later phases are identified, and some may involve transportability - for example, demonstrating that a weapon system *truly is* C-130 transportable. MTMCTEA computer aided engineering (CAE) should be used to analyze transportability at this early stage of development.

In Phase 0, the major documents/events that MTMCTEA must review/participate in to ensure transportability has been adequately addressed are the Operational Requirements Document (ORD), Cost and Operational Effectiveness Analysis (COEA), and the Test and Evaluation Master Plan (TEMP).

The ORD is written by the future users or user's representatives before Milestone I. The ORD is based on the MNS but is more detailed. The ORD links the MNS with the systems specifications. The transportability section of a SAMPLE ORD could read as follows, "The [WEAPON SYSTEM] must meet US and NATO countries' highway legal limits; have military standard lifting and tiedown provisions per MIL-STD-209; meet the GIC rail outline diagram; pass the



MTMCTEA



rail impact test (MIL-STD-810); be marine transportable on LARC-LX and larger vessels/ships; be internally transportable in the CH-47 helicopter in the high-hot scenario; be externally transportable in the CH-47 and UH-60 helicopters; be transportable in its operational configuration in the C-130, C-141, C-17, and C-5 aircraft; and be air droppable from the C-130 and C-141 aircraft." In accordance with DOD 5000.2M [page 3-1-3], transportability should normally be addressed in paragraph 6b of the ORD. Special transportation requirements such as LAPES may be addressed in paragraph 5e of the ORD.

COEAs evaluate the costs and benefits of alternative courses of action to meet recognized defense needs. The COEA shows the relative advantages and disadvantages of the alternatives being considered. Of the alternative systems, one typically represents the current program or status quo (base case). An improved version of the current program and other alternatives, including applicable foreign systems, are assessed against the base case program in terms of changes in cost and effectiveness. COEAs provide information on the sensitivity of alternatives to potential changes in key assumptions, variables, and constraints. Some alternatives may be inherently more transportable than others, so MTMCTEA should be the transportability/deployability point of contact for COEAs. It is certainly undesirable to develop a new weapons system that is less transportable and deployable than the system it is to replace. It is also important to consider changes to the *unit's* strategic lift requirement caused by the introduction of a new weapons system.

The TEMP states the overall testing program for the weapons system. Testing must be included to verify that critical system's characteristics specified in the ORD can be met. MTMCTEA must be involved with writing the TEMP since the TEMP must include transportability testing.

If transportability is included in the Critical System Characteristics section of the ORD, it should appear in the Critical Technical Parameters Matrix (see page 7-1-11 of DODM 5000.2-M). The TEMP should support the requirements stated in the ORD. The TEMP should refer to supporting military standards.

Milestone I, Concept Demonstration Approval, is the decision point at the end of Phase 0. A favorable decision at Milestone I allows the project to move to Phase 1, Demonstration and Validation. MATDEV must submit an initial transportability report to MTMCTEA not later than 90 days before Milestone I decision review. MTMCTEA will use the data in the report to prepare an engineering analysis that will support the Milestone decision review and may suggest actions to improve the system.

3. Phase I, Demonstration and Validation (DEM/VAL)

In Phase I, MTMCTEA must review the System Specification (SPEC). MTMCTEA should also participate in the Source Selection Evaluation Board (SSEB) to ensure transportability has been adequately addressed. This involvement will also ensure the transportability requirements stated in Phase 0 are continued in the requirements documents and prototypes of this phase. MTMCTEA must review any proposed changes to the ORD or TEMP. An interim transportability report must be submitted to MTMCTEA by the materiel developer not later than **90 days** before Milestone II. Information on all prototypes and support equipment must be submitted.

If alternative *design* approaches are being pursued during Phase I, then the COEA should be updated. MTMCTEA should be the transportability/deployability point of contact for the COEA. MTMCTEA should also participate in

the Source Selection Evaluation Board (SSEB). At Milestone II, program risk must be thoroughly assessed. The milestone decision authority must validate the weapons system performance objectives and thresholds. The transportability portion of these objectives and thresholds will have been analyzed by MTMCTEA. If they are met, the Commander, MTMC will grant transportability approval in accordance with **AR 70-44/47**. The Commander, MTMC has delegated the transportability approval authority to MTMCTEA. Therefore, in most cases, MTMCTEA will actually be the agency granting transportability approvals. A favorable decision at Milestone II allows the project to move into Phase II, Engineering and Manufacturing Development (EMD).

4. Phase II, Engineering and Manufacturing Development

Milestone II allows the project to move into Phase II, Engineering and Manufacturing Development. By Phase II, the transportability characteristics of the item have been identified and the design of the item is being finalized. In this phase, MTMCTEA should review or participate in the Materiel Fielding Plan (MFP), test plans, and test reports. Transportability testing of the final item must be coordinated with MTMCTEA. This testing includes lifting and tiedown provision strength tests, rail impact tests, Air Force aircraft test loadings, airdrop and LAPES tests, and helicopter lift tests. A final transportability report must be submitted to MTMCTEA not later than 90 days before Milestone III. Information on the item and all support equipment must be submitted. If the item meets the transportability requirements of the requirement documents, MTMCTEA will affirm transportability approval

in accordance with **AR 70-44/47**. If the item does not meet the requirements, transportability approval will be withdrawn until the problem is corrected. Transportability approval is required by Milestone III at the conclusion of Phase II. A satisfactory Milestone III allows the project to move into Phase III, Production and Deployment.

5. Phase III, Production and Deployment Phase

During Phase III, the item is produced and fielded. Transportability can influence design only at great expense, in terms of time and cost, once production begins. Any analysis MTMCTEA performs after production has begun will be more of a description of shipping restrictions rather than a transportability engineering analysis. If a production item's weight or dimensional characteristics change, the developer should submit a revised transportability report to MTMCTEA. Occasionally, a Milestone IV, Major Modification Approval, may be required if a major modification is planned to a system. Of course, the modified system should still meet its transportability requirements, and the developer must obtain MTMCTEA's concurrence for a successful Milestone IV.

MTMCTEA's concurrence may be required as part of a Preplanned Product Improvement (P3I). Ideally, the characteristics of the improved item will be considered during early transportability testing. If it is known or suspected that an item will experience weight growth, the initial testing should be based on the heavier weight. This strategy usually reduces the amount of transportability testing that must be done to support P3I.

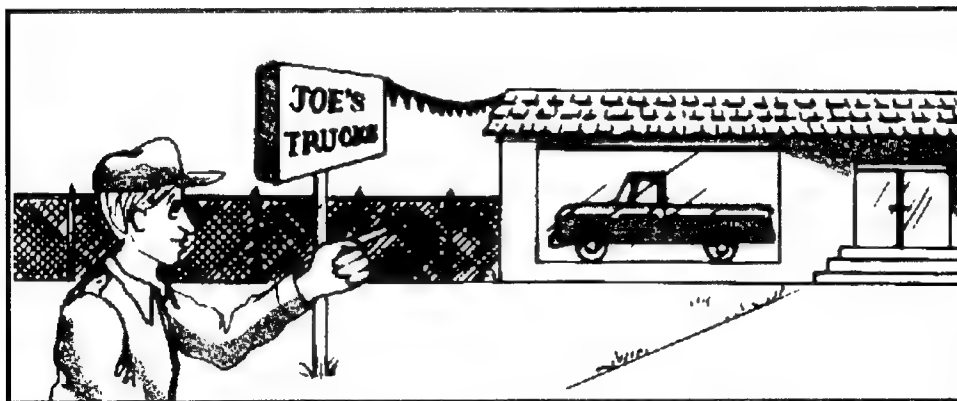
NONDEVELOPMENTAL ITEMS (NDI)

DODI 5000.2 requires NDI to be used to meet acquisition requirements where possible. NDI includes commercial items adapted for military use, weapons systems of Allied nations, and US weapon systems in use with another service. The NDI acquisition cycle is not a separate cycle, but a tailoring of the R&D acquisition cycle.

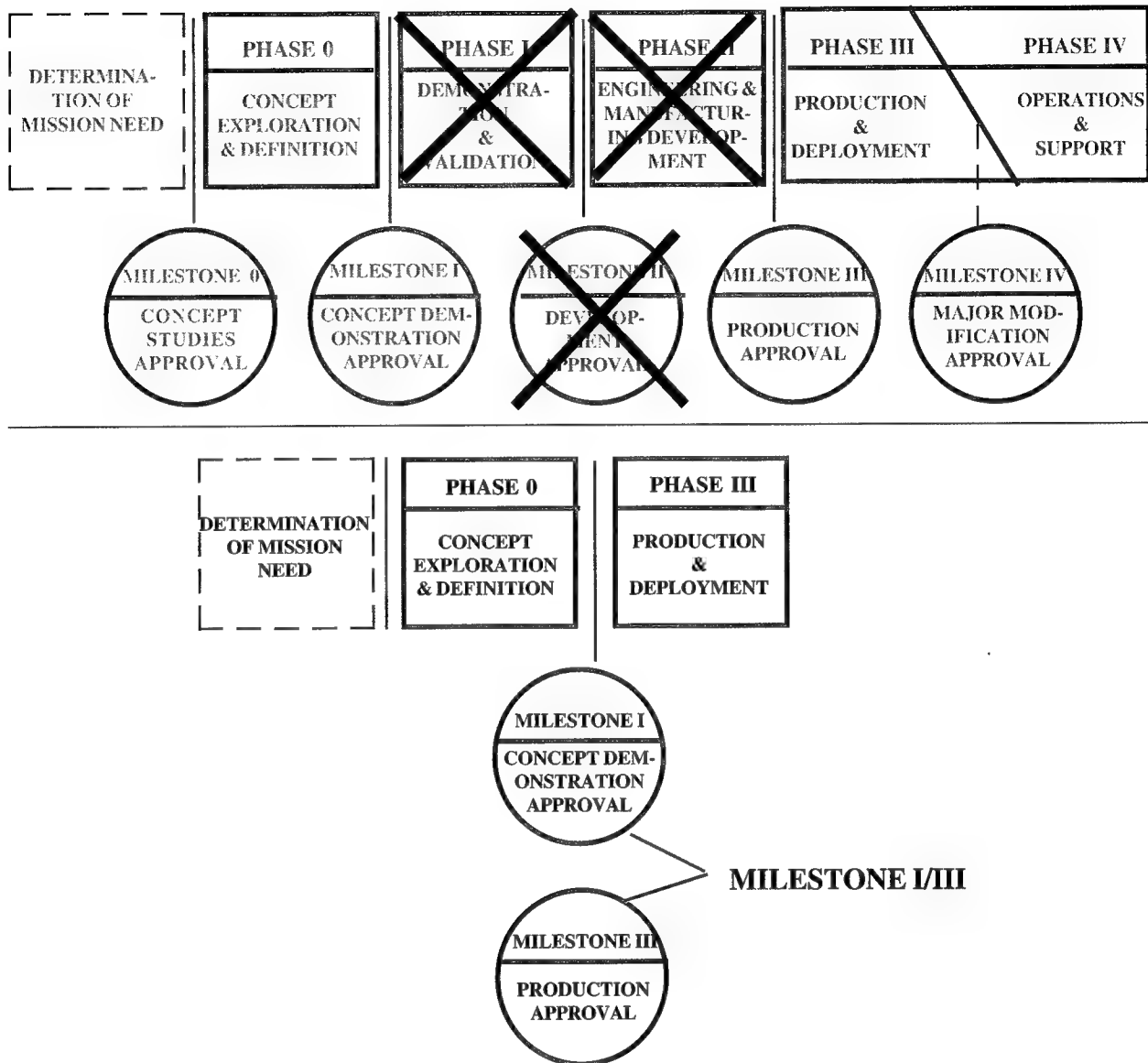
The NDI cycle consists of the Concept Exploration and Definition phase, Milestone I (the NDI decision confirmation point), the Acquisition Documentation phase, Milestone III (the pro-

duction decision point), and the Production and Deployment phase.

If no R&D engineering, design, integration, test, or evaluation effort is needed, Phases 1 and/or 2 could be skipped or compressed. The Milestone II decision could be skipped, and the program could proceed from Milestone I to Milestone III. This compression of the acquisition cycle affects the timing of acquisition actions and required transportability actions.



NDI ACQUISITION MILESTONES & PHASES



1. Concept Exploration Phase

In the concept exploration phase, the major documents/events that MTMCTEA must review/participate in are the Market Investigation and Operational Requirements Document (ORD).

It is essential that transportability be adequately addressed in all of these documents/events be-

cause of the "fast-track" nature of the NDI acquisition cycle. An initial transportability report, the action in this phase, must be submitted to MTMCTEA by the materiel developer. The report and a copy of the market survey report must be submitted not later than 90 days before Milestone I. Then MTMCTEA will conduct an initial transportability engineering analysis. This analysis will inform decision makers about the

transportability of items available in the commercial market and will be essential for the Milestone I decision.

2. Acquisition Documentation Phase

In the acquisition documentation phase, the major documents that MTMCTEA must review are the Functional Purchase Description or Specification and the Test and Evaluation Master Plan (TEMP). If possible, all transportability testing should be completed during pre-production qualification testing (PPQT). To ensure the transportability requirements have been carried through from the requirements document, the Functional Purchase Description or Specification must be submitted to MTMCTEA no later than 30 days prior to Milestone III. Based on the review of this information, MTMCTEA will approve any item that meets the transportability requirements of the Functional Purchase Description or Specification.

3. Production and Deployment Phase

In the production and deployment phase, MTMCTEA must review all candidate items to ensure they meet the transportability require-

ments of the requirements documents. A transportability report, the first action in this phase, must be submitted to MTMCTEA by the materiel developer. This report must contain the required transportability information on all candidate items and must be submitted not later than 30 days before contract award.

Transportability approval will be granted for all candidate items that meet the requirements of the Functional Purchase Description. A final transportability report, the second transportability action in this phase, must be submitted to MTMCTEA by the materiel developer at the completion of the first article testing (or initial production testing). First article testing must include all transportability testing that was not completed during PPQT. MIL-STD-209 tests should be performed on the first article, even if performed previously, to validate the manufacturing process. Transportability approval will be affirmed by MTMCTEA at this time. If the first article does not meet the requirements of the Functional Purchase Description or Specification, transportability approval will be withdrawn. MTMCTEA must grant transportability approval before the item can enter the production and deployment phase.

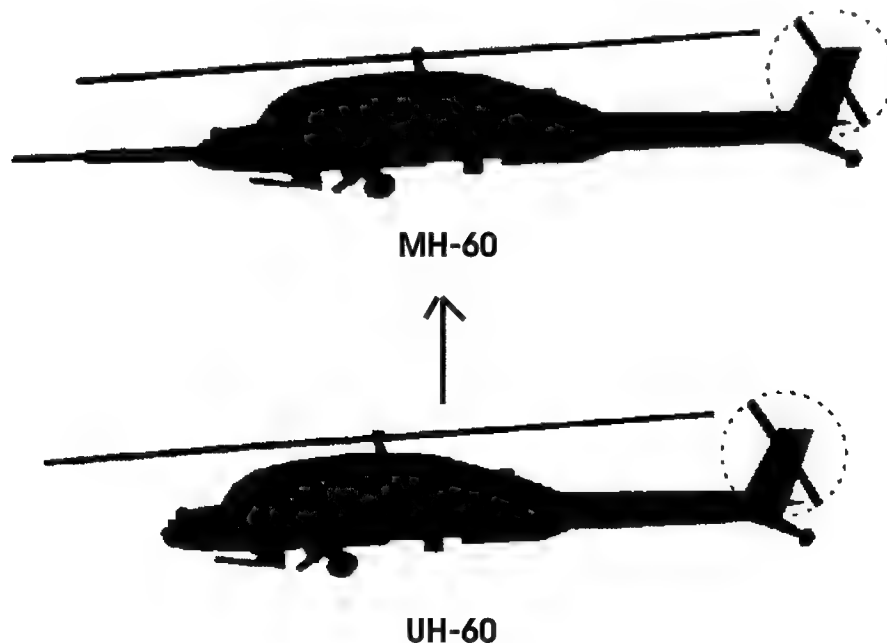
MATERIEL CHANGES

Before any decision is made to replace materiel through new development or procurement, materiel change of existing equipment will be considered. **AR 70-15** (Materiel Change Management) requires that the materiel change sponsor coordinate with MTMCTEA to get transportability approval for all items that are or could become transportability problem items, as defined in **AR 70-44/47**.

MTMCTEA's role in the materiel change management program includes review/participation in updates of requirements documents, specifications, and test and evaluation master plans. The requirements transportability approval should be established prior to the meeting of the Configuration Control Board. A transportability report must be submitted by the materiel change sponsor at least 90 days prior to the materiel decision review. Transportability testing must be com-

pleted by this date. If the system meets the transportability requirements of the updated system requirements document and specification, MTMCTEA will grant transportability approval in accordance with **AR 70-44/47**. If the item does not meet the requirements, approval will be denied.

Much of the older equipment in the current Army inventory is difficult to safely and efficiently deploy because of its outdated transportability characteristics. When military equipment is reprocured, it is important to take advantage of lessons learned during deployments by upgrading specifications and technical data packages (TDPs) to consider rapid deployment in today's transport environment. In addition, the weight growth seen by many systems over the years may adversely affect transportability.



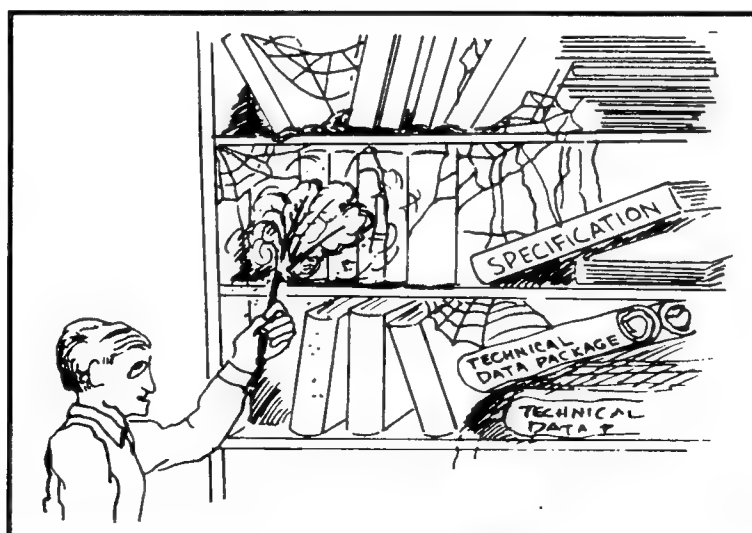
REPROCUREMENTS

Reprocurements, also called rebuys, refer to items that are periodically bought throughout their normal life cycle or bought when additional quantities are required after the initial acquisition is completed. **AR 70-44/47** requires that each reprocurement have transportability approval affirmed by MTMCTEA. This approval is required to ensure that the transportability requirements and military standards referenced in the original technical data package or specification are current, and that the newly produced items conform to the specification. If the transportability requirements are not current, they must be revised and brought up to date.

The functional purchase description, specification, or technical data package must be submitted by the materiel developer at least 30 days before the data call. MTMCTEA will approve the draft specifications or suggest modifications to have them meet current requirements. A transport-

ability report must be submitted by the materiel developer after first article (or initial production) testing but before materiel release. If the system meets the transportability requirements of the approved specification, MTMCTEA will affirm transportability approval. If the item does not meet the requirements, transportability approval will be withdrawn until the problem is corrected.

Reprocurements usually must have some transportability testing. If the item itself is unchanged, but is being built by a new manufacturer, then **MIL-STD-209** testing is necessary. **MIL-STD-209** testing is also necessary if the item is built by the same manufacturer and there has been a production break of more than 1 year. If weight, dimensions, and/or lifting and tiedown provisions have changed, then complete transportability tests must be performed. Complete transportability testing is also necessary when the original specifications do not meet modern requirements.



TRANSPORTABILITY ASSISTANCE

Transportability help from MTMCTEA is available to developers anytime during the acquisition cycle. Throughout the acquisition process, developers may need assistance. The following is a list of typical acquisition actions for which help is available:

- PRELIMINARY CONCEPT STUDIES
- TRADE-OFF ANALYSIS
- CONCEPT FORMULATION PLAN
- CONFIGURATION MANAGEMENT PLAN
- ILS MANAGEMENT TEAM
- PROGRAM MANAGEMENT PLAN
- REQUEST FOR PROPOSAL
- SPECIAL TASK FORCE
- SPECIAL STUDY GROUP
- TEST AND EVALUATION MASTER PLAN
- INTEGRATED LOGISTIC SUPPORT PLAN
- IN-PROCESS REVIEW
- OPERATIONAL REQUIREMENTS DOCUMENT
- SYSTEM SPECIFICATION
- SOURCE SELECTION EVALUATION BOARDS
- DEVELOPMENT TEST/OPERATIONAL TEST
- INDEPENDENT EVALUATION PLAN
- SYSTEM SUPPORT PACKAGE
- MATERIEL FIELDING PLAN
- BASIS OF ISSUE PLAN
- TABLE OF ORGANIZATION AND EQUIPMENT
- MATERIEL CHANGE MANAGEMENT
- REPROCUREMENTS
- COST AND OPERATIONAL EFFECTIVENESS ANALYSIS (COEA)
- LOGISTICS IMPACT ANALYSIS (LIA)
- SUSTAINABILITY ANALYSIS (SA)

TRANSPORTABILITY TESTING

1. General

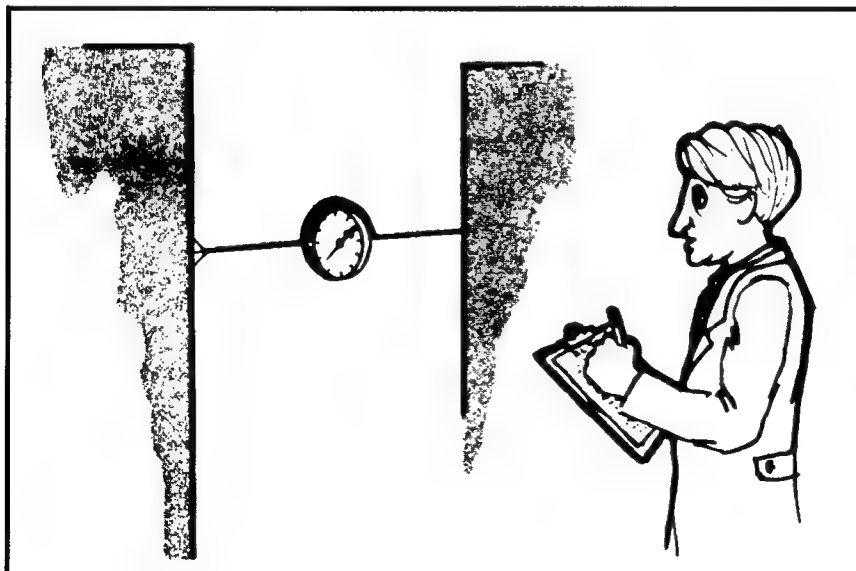
Transportability testing is required during the acquisition cycle as a part of Developmental Testing (DT). This testing is essential because the performance of an item under actual transport conditions often cannot be accurately determined by mathematical calculations. Test procedures should be coordinated with MTMCTEA at least 30 days before the test date. MTMCTEA should be notified of the exact test time and location at least 5 days before the tests. Transportability tests should be witnessed by MTMCTEA or other approved Government personnel. The ability of an item to withstand the rigors of transport must be demonstrated by:

- Lifting and tiedown provision strength test
- Helicopter lift test (internal and/or external)
- Air Force aircraft test loading

- Airdrop test
- Low altitude parachute extraction test
- Rail impact test

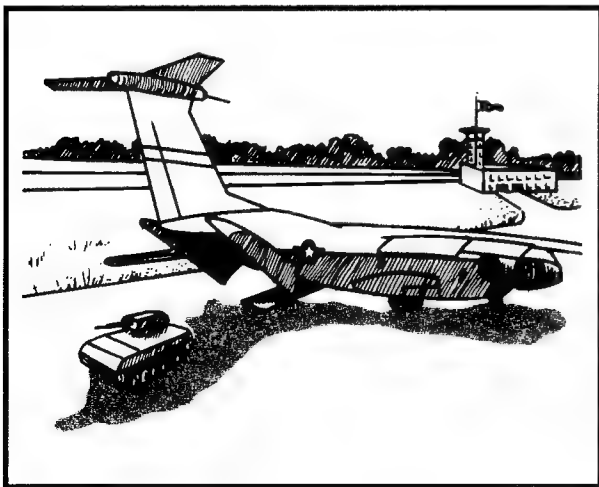
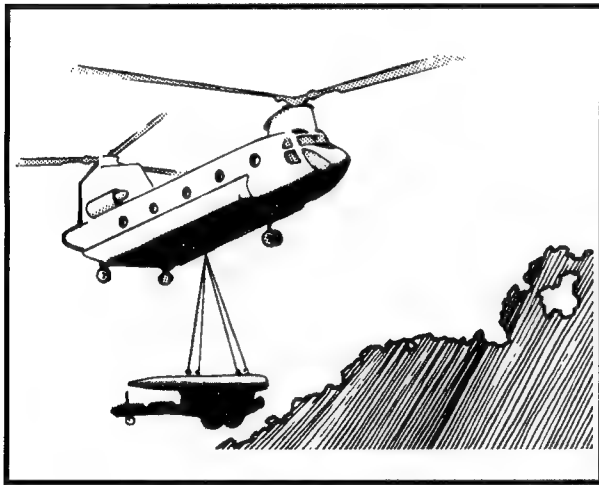
2. Lifting and Tiedown Provision Strength Test

The lifting and tiedown provisions on all items of equipment must be tested to the limits specified in **MIL-STD-209**. The provision must be tested **AFTER** it has been installed on the equipment. A dynamometer pull test on each provision, to include the provision's connection to the structural frame of the item, is the simplest way to test the strength of each provision. Equipment with a requirement for airdrop or LAPES must be tested also to the requirements of **MIL-STD-814** for suspension, tiedown, and extraction provisions. Equipment with a requirement for EAT must also be tested in accordance with **MIL-STD-913**.



3. Helicopter Lift Test (Internal and External)

The helicopter internal transport test determines fit and the feasibility of tiedown procedures. This test usually is required only when the fit is expected to be close. The helicopter external lift tests (in accordance with **MIL-STD-913**) determine the ability of the item to be lifted, the stability of the item in flight, the speed at which the item can be flown, and the rigging procedures for lifting the item. All items with a helicopter external lift requirement must pass a helicopter flight test.

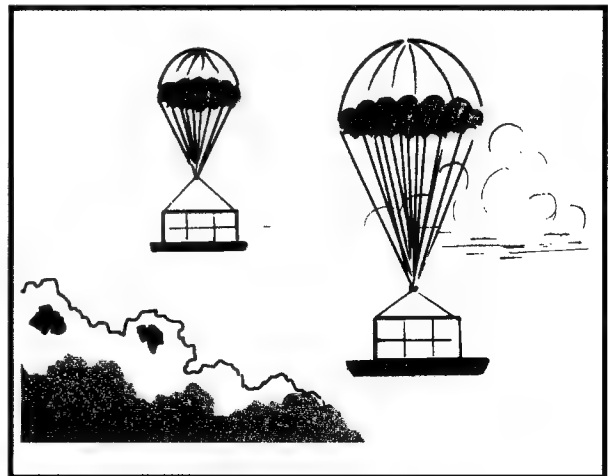


4. Air Force Aircraft Test Loading

An aircraft test loading determines the fit, loading procedures, and tiedown procedures. Also, it ensures that none of the aircraft design limitations (axle loads and ramp hinge loads) are exceeded. This test loading is conducted only when required by the Air Force. Failure to pass an aircraft test loading will negate air transport. Validation loadings are less expensive than test loadings and may be required when mathematical calculations indicate that fit will be tight.

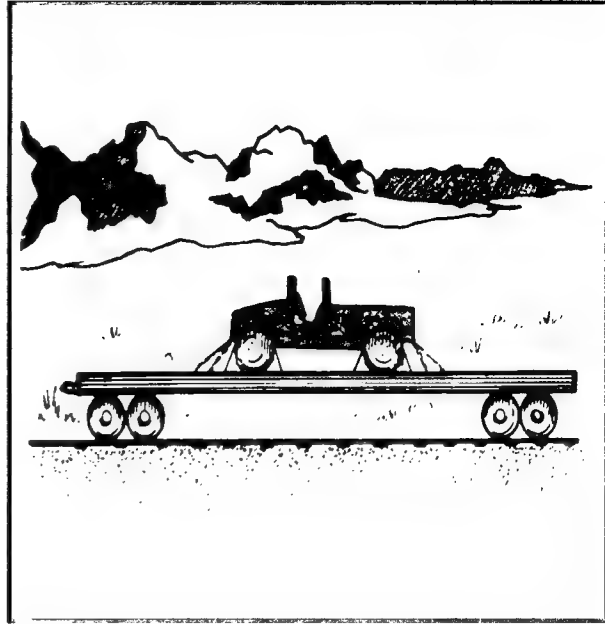
5. Airdrop and LAPES Tests

The airdrop and LAPES tests determine the adequacy of rigging procedures and the ability of the item to survive the landing impact. These tests shall be performed in accordance with **MIL-STD-814** and **MIL-STD-669**. After these tests, the item must be undamaged and operable.



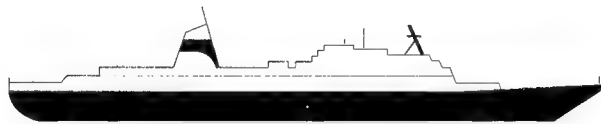
6. Rail Impact Test

Rail transport subjects the item to the most severe longitudinal impacts of any transport mode. The rail impact test, therefore, is the most severe transportability test. The standard rail impact test, **MIL-STD-810**, tests the integrity of the item and the adequacy of the rail tiedowns and tiedown procedures. Any item that passes the **MIL-STD-810** test should be capable of rail transport without damage to the item or the tiedowns. All items with a rail transport requirement must pass a rail impact test. Failure to do so may negate rail transport.





SECTION II



TRANSPORTABILITY REQUIREMENTS



4. HOW TO DETERMINE AND WRITE REQUIREMENTS

GENERAL

Transportability requirements must be provided in all requirement documents. Determining and then writing these requirements are essential to achieving the level of transport required of the item to perform its mission. The meaning of different transportability requirements and the limitations associated with each requirement are explained in this chapter.

- **TRANSPORTABILITY REQUIREMENTS**
- **TRANSPORTABILITY PARAGRAPH FOR
REQUIREMENT DOCUMENTS**

TRANSPORTABILITY REQUIREMENTS

DODI 5000.2 states that transportability characteristics will be identified for all modes that could possibly be used to transport a new type of equipment. **AR 71-9, *Materiel Requirements***, states that transportability must be included in all requirement documents. Simply including transportability, however, is not enough. The transportability requirements of an item to be procured must reflect the mission requirements of that item. For example, if an item has a rapid-

deployment-type mission, it must be air transportable (by C-130 and C-141) in an operational configuration. The mission requirements must be known when the original need for the item is developed. Once these requirements have been developed, the determination of transportability requirements is simple. The options available for each mode when a transportability requirements statement is assembled are explained in detail in this section.

HIGHWAY

Almost every item of military equipment, be it a self-propelled vehicle, a trailer, or cargo, uses the highway mode. All equipment (with the possible exception of aircraft and large marine craft) must be capable of highway transport. This is especially true of equipment with a rapid-deployment-type mission, since highway transport is essential to the delivery of equipment to the port of embarkation for deployment as well as within the theater of operations.

The optional statements for the highway portion of the transportability requirements statement for wheeled vehicles are provided below. Tracked vehicles and skid-mounted (or other) equipment must be included in the prime mover combination when highway transport restrictions are discussed.

The item must:

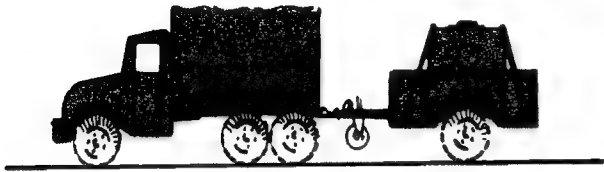
1. Meet US and NATO countries' highway legal limits

The choice of this option means that highway transport would be almost unrestricted. This is the most restrictive, practical highway transport statement. The vehicle or loaded prime mover combination would have to be within both the US and NATO size and weight limits listed in chapter 2.



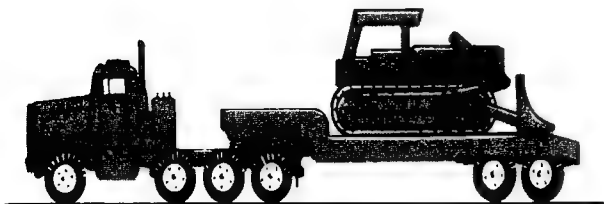
2. Meet US highway legal limits

The choice of this statement means that the vehicle or loaded prime mover combination could have the maximum dimensional and weight characteristics listed under the US highway limits in chapter 2. Highway transport in the United States would be almost unrestricted, with only isolated States requiring permits for highway transport.



3. Be within the maximum permit limits established by the individual States

The choice of this statement means that vehicles or loaded vehicle combinations could exceed the legal limits for highway transport by obtaining permits for each move but could not exceed the maximum permit limits established by the States. This statement should be used only when the available prime movers already exceed the legal limits and only when there are no alternatives. The use of this statement will put an added logistic burden on the user.



4. Be highway transportable

The choice of this statement means that a contractor could design a vehicle or have a loaded prime mover combination that would require certification as essential to national defense (chap 2). Since highway transport that requires certification as essential to national defense is unacceptable, this statement should not be used, because it provides no limits for highway transport.

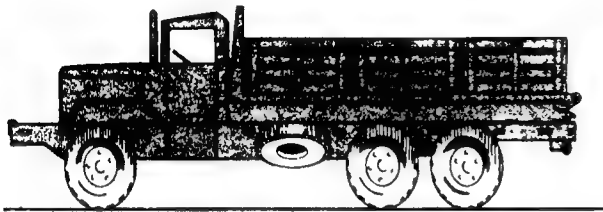


5. Be highway transportable, with a turning radius of [50 feet], a maximum gross weight of [130,000 pounds], a maximum single axle load of [25,000 pounds], and a maximum tandem axle load of [45,000 pounds]

The choice of this statement means that a contractor could design a vehicle or have a loaded prime mover combination that would require certification as essential to national defense (chap 2). However, the design is more constrained than if Statement 4 were used. This statement should be used only when other requirements make it impossible to design equipment that meets highway permit limits and it is known that the equipment will be based at a specific installation and deployed through a specific port. Then the equipment can be designed to meet the constraints of a specific highway route. However, it may not be transportable on any other highway.

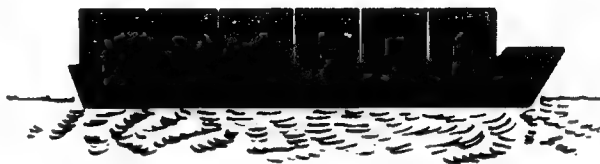
6. Be transportable on/by (specify) transport vehicle

The choice of this statement means that the size and weight of the item of equipment would be limited to the dimensional and weight capabilities of a specific transport vehicle.



7. Highway transport not required

This statement should be used only when the item of equipment will never require highway transport. This statement should apply only to extremely large items, such as barges or locomotives.



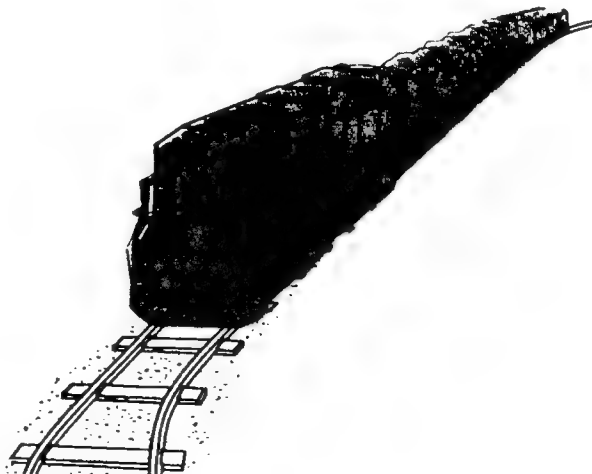
RAIL

The rail mode, like the highway mode, is used to transport almost every item of military equipment (except aircraft). During deployment, most military equipment will be transported by rail from installations to points of embarkation and from ports to inland areas once the theater of operations has been reached. Rail transport is, therefore, essential to deployment.

The optional statements for the rail portion of the transportability requirements statement are provided below. Only standard-gauge rail transport is covered by this example.

The item must:

1. Meet the GIC (Gabarit International de Chargement) outline diagram



2. Meet the Envelope B outline diagram

The choice of this statement means that rail transport in Europe will be possible, but only certain rail lines can be used. These rail lines generally connect major population centers. Envelope B is slightly higher and wider than the GIC outline diagram (chap 2).

3. Meet the AAR (Association of American Railroads) outline diagram

The choice of this statement means that rail transport in North America will be almost unrestricted. The AAR outline diagram is higher and slightly narrower than the Envelope B outline diagram (chap 2).

4. Meet the DOD clearance profile

The choice of this statement means that rail transport in the United States will be limited to the Strategic Rail Corridor network (STRACNET) and a limited number of other rail lines. Even on these rail lines, surcharges, operations at restricted speeds, and other limitations may be necessary. Transportation over foreign rail lines may not be possible. The DOD clearance profile is higher and wider than the AAR outline diagram and Envelope B outline diagram (chap 2).

5. Be rail transportable

The choice of this statement means that a contractor could design an item of equipment that would always require special routing or special provisions for rail transport. Rail transport might not even be possible over the rail lines that would actually have to be used in a contingency. Therefore, this statement should not be used, because it provides no limits for rail transport. **Rail transport is very likely to be impractical for items that do not meet the DOD clearance profile.**

6. Rail transport not required

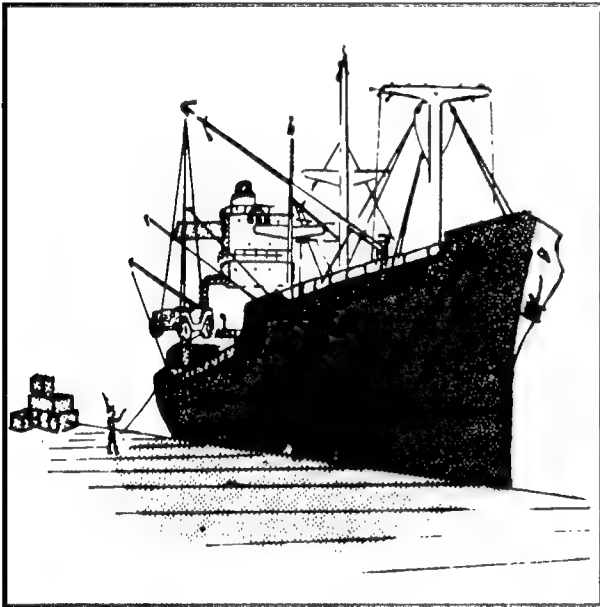
This statement should be used only when the item of equipment will never require rail transport. This should apply only to extremely large items, such as watercraft, or to very sensitive or delicate equipment, such as aircraft.

7. Meet the military standard rail impact test

If rail transport is required, the item of equipment must pass a rail impact test to ensure it can be safely transported by rail. The MIL-STD-810 test verifies the ability of the item to withstand the rigors of rail transport.

WATER

All military equipment (except self-deploying aircraft) must be capable of water transport because most equipment in a strategic deployment will be transported by ship. Equipment must be capable of transport on barges and tactical watercraft. This capability will ensure the equipment can be deployed in LOTS (logistics-over-the-shore) operations.



The optional statements for the water portion of the transportability requirements statement are as follows:

The item must:

1. **Be marine transportable on (choose the smallest lighterage required to transport the item: LARC-LX, LCM-6, LCM-8, LCU-1646, or LCU-2000) and larger vessels/ships.** The LARC-LX has the same payload capability as the LCM-8, but the cargo area is slightly smaller. Therefore, requirements documents should usually require items to be marine transportable on the LARC-LX and larger vessels

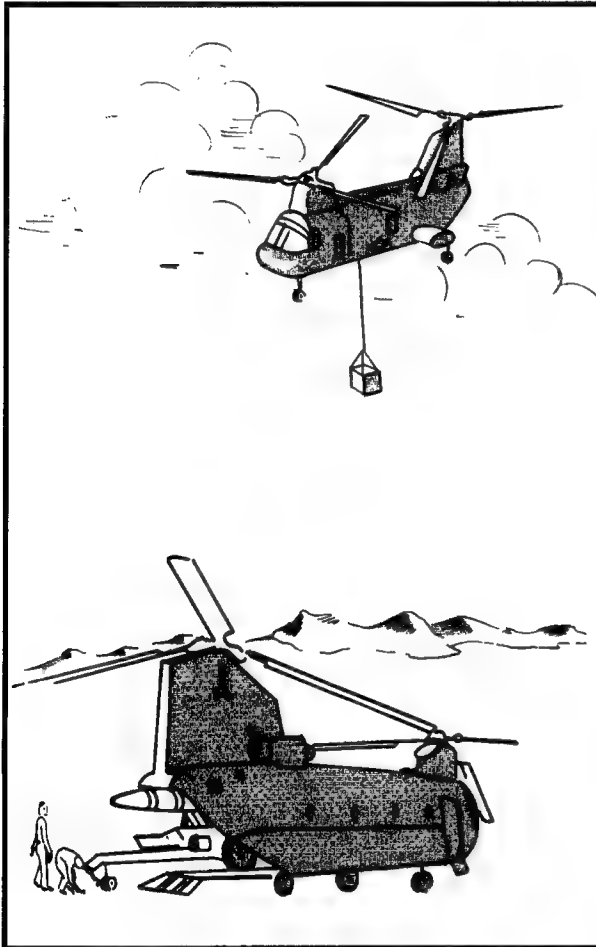
The choice of this statement specifies the smallest watercraft on which the item of equipment must be capable of being transported and covers all larger vessels/ships.

2. Marine transport not required

This statement can only be used if marine transport will never be required. Since all military equipment must be capable of marine transport, the only equipment that would not require marine transport would be self-deploying aircraft and marine vessels or towed barges/vessels.

AIR (ROTARY WING)

Rotary-wing aircraft are used primarily for short-range tactical transport missions. The rotary wing mission requirements and estimated weight of the equipment should be known before specifying rotary wing transport. This is because the



lift capability of helicopters depends on several factors, including temperature, altitude, and amount of fuel in the aircraft.

The optional statement for the rotary wing portion of the transportability requirements statement is provided below.

The item must be transportable in/by the:

- a. UH-1 (externally)
- b. UH-60 (externally)
- c. CH-47 (specify internally, externally, or both; if externally, specify by single-point or dual-point lift or both)

and meet MIL-STD-913 (when EAT is a requirement).

(Specify scenario, for example: in the high-hot scenario)

These are the only rotary-wing aircraft in the active Army that can routinely transport equipment. Other rotary wing aircraft in the inventory of the Department of Defense that can transport equipment are the CH-46 and CH-53 cargo helicopters.

AIR (FIXED WING)

Fixed-wing aircraft transport is the most important mode in terms of rapid strategic mobility. The four US Air Force (USAF) prime mission cargo aircraft are the C-130, C-141, C-17, and C-5. The C-130 is a tactical (intratheater) aircraft; the C-141 and C-5 are strategic (intertheater) aircraft. The C-17 can support tactical or strategic missions; however, it is unlikely to be used to transport items into hot landing fields. Equipment with a rapid-deployment-type mission must be air transportable in an operational configuration in the C-130 and C-141 aircraft. The limited availability of the C-5 and C-17 aircraft dictates that, if the equipment cannot be transported in the C-141 aircraft, then it probably will have to be deployed by ship. From a practical viewpoint, equipment that is air transportable only in the C-5/C-17 aircraft could almost be considered as non-air transportable in time of war. The optional statements for the fixed-wing air portion of the transportability requirements statement are provided below.

The item must:

1. **Be air transportable in the (*choose as many as required*)**
 - a. C-130
 - b. C-141
 - c. C-5
 - d. C-17
 - e. CRAF (Civil Reserve Air Fleet)(*choose the aircraft required to transport the vehicle: B-747, DC-8, DC-10*)

This statement specifies which aircraft are required. It is essential that the aircraft required are

listed in the requirements document (see chap 2 for aircraft limitations).

2. Meet MIL-STD-1791

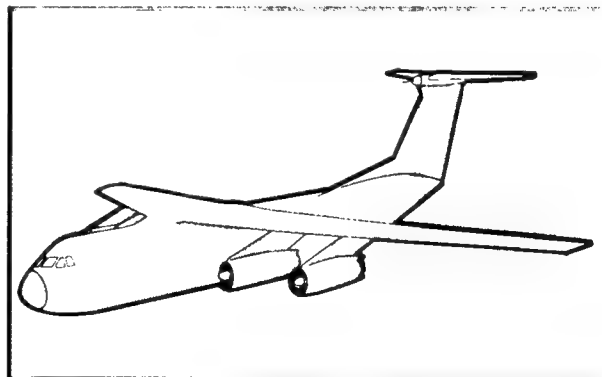
MIL-STD-1791 is the military standard that states the requirements for air transport in USAF cargo aircraft. This statement must be added if C-130, C-141, C-5, or C-17 transport is required.

3. Be air droppable from (*choose the required aircraft: C-130, C-141, C-5, C-17*) aircraft and meet MIL-STD-669 and MIL-STD-814

This statement should be used when airdrop from USAF aircraft is required (see chap 2 for limitations).

4. Be capable of low altitude parachute extraction (LAPES) from (*choose the required aircraft: C-130, C-17*) aircraft

This statement should be used when LAPES from USAF C-130 or C-17 aircraft is required (see chap 2 for limitations).



5. Be air transportable without the need for load spreading or approach shoring

This statement should be used when vehicles must be loaded and unloaded in a roll-on/roll-off, operational configuration for quick-reaction-type forces. Load spreading and approach shoring add both time and logistic burdens to air transport requirements and should be avoided whenever possible.

6. At least (*specify number of items*) shall be capable of transport in one (*specify model of aircraft*)

7. (*If equipment is a system*): Be transportable by no more than (*specify number and model of aircraft*) sorties.

This statement means that a limitation is set on a number of sorties required to transport a system, thereby restricting the total size of the system.

8. Be reduced/disassembled to transport configuration in (*specify*) minutes by (*specify*) personnel.

9. Be reassembled to operational configuration in (*specify*) minutes by (*specify*) personnel.

These two statements set maximum times and personnel requirements for assembly and disassembly required for transport. Setting these maximums limits the amount of disassembly required for transport, thereby ensuring that the equipment will be capable of transport and be capable of operation shortly after disassembly or assembly begins. This eases the logistic burden on the deploying unit as well as decreases the time required to deploy. (Disassembly, however, introduces the possibility that parts may be lost during transport, thus preventing reassembly at the final destination.)

10. Be reduced/reassembled from/to operational configuration without disconnecting flight control surfaces or requiring a maintenance test flight

This statement minimizes helicopter assembly and disassembly required for air transport. It eliminates the requirement for a maintenance test pilot at the port of debarkation, easing the logistic burden on the deploying unit as well as decreasing the time required to deploy.

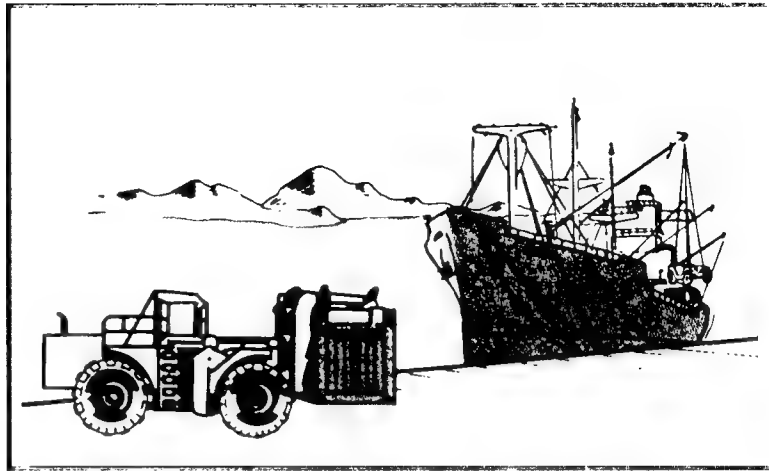
11. Air transport is not required

This statement should be used only when the item of equipment will never require air transport. This should apply only to extremely large or heavy items that could be deployed only by ship.

CONTAINERS

Military equipment should be transportable in 8.5-foot-high by 8-foot-wide by 20-foot-long ANSI/ISO containers where practical, so that the intermodal benefits of containerization can be realized and container-ships can be more effectively used to support deployments. The following would be the container portion of the transportability requirements statement.

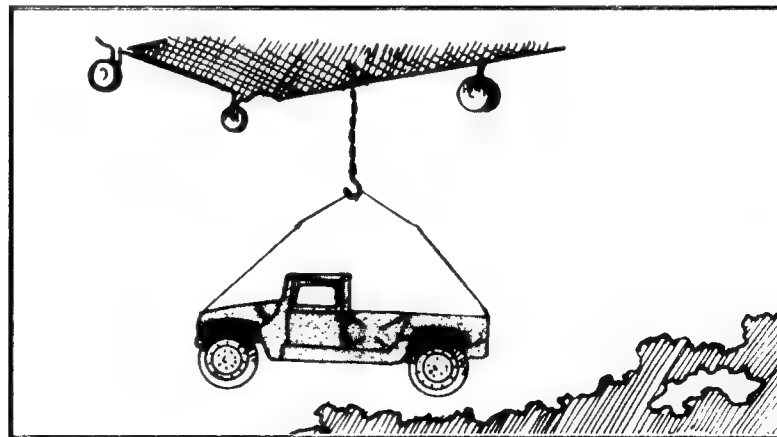
- **The item must be transportable in ANSI/ISO containers (specify size).**



LIFTING AND TIEDOWN PROVISIONS

All equipment must have adequate lifting and tiedown provisions since these provisions are essential to efficient transport. Vehicles must have provisions designed for the gross vehicle weight (fully loaded vehicle). All transportability requirements statements must contain the following lifting and tiedown statement.

- **The item must have military standard lifting and tiedown provisions (MIL-STD-209).**



(If low velocity airdrop or LAPES is required, the item also must have tiedown provisions in accordance with **MIL-STD-814**. If EAT is required, the item's lifting provisions must also comply with **MIL-STD-913**).

GENERAL REQUIREMENTS

Other general transport requirement statements that could be included in the transportability requirements statement are listed below.

The item must:

- **Be transportable in climatic categories (*specify from AR 70-38*).**

The choice of this statement provides for the capability of an item to be transported in various climatic categories of extreme temperatures.

- **Reduce/not increase deployment transport requirements of the receiving military unit(s).**

The choice of this statement dictates that an item (or system) must not be larger or heavier than the item (or system) it replaces.

- **Be transportable at its maximum gross vehicle weight (GVW) during (*choose mode(s)*) - highway, air, rail, marine, or all-mode transport.**

The choice of this statement ensures that the equipment can be transported at its maximum operational weight by all or by specific modes. All equipment should be capable of all-mode transport at its GVW.

In certain situations, other statements may be specified to ensure transportability.

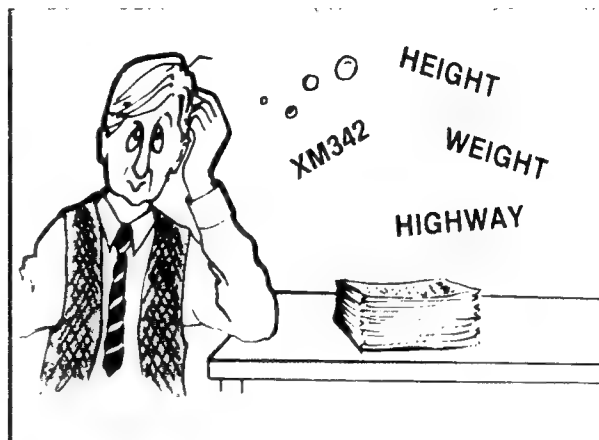


TRANSPORTABILITY PARAGRAPH FOR REQUIREMENT DOCUMENTS

The following paragraph should be used to develop transportability requirements for all items of equipment. (The options listed below are provided to develop the transportability paragraph.)

"The (name of equipment) (choose from IA or IB) have military standard lifting and tiedown provisions (**MIL-STD-209**), (choose from II), (choose from III), (choose from IV), and (choose from V)."

(Use **MIL-STD-1366** and chap 2 of this pamphlet for design parameters and guidance to select the option that describes the vehicle's transportation need.)



I. (Choose only one from A or B)

A. (Wheeled vehicles only)

1. Must meet US and NATO countries' highway legal limits
2. Must meet US highway legal limits
3. Must be within the maximum permit limits established by the individual States
4. Must be highway transportable
5. Must be highway transportable with certain characteristics such as maximum gross weight, maximum axle load, turning radius, and so forth.
6. Highway transport not required (*remove blank*)

B. (Tracked vehicles and skid-mounted equipment only)

1. And its prime mover combination must meet US and NATO countries' highway legal limits. The (name of equipment) must
2. And its prime mover combination must meet US highway legal limits. The (name of equipment) must
3. And its prime mover combination must be within the maximum permit limits established by the individual States. (The (name of equipment) must
4. And its prime mover combination must be highway transportable. The (name of equipment) must
5. Highway transport not required (*remove blank*)

II. (Choose one - If A, B, C, D, or E is selected, then G must be included)

- A. Meet GIC (Gabarit International de Chargement) outline diagram
- B. Meet Envelope B outline diagram
- C. Meet AAR (Association of American Railroads) outline diagram
- D. Meet DOD clearance profile
- E. Must be rail transportable.
- F. Rail transport not required (remove blank)
- G. Meet military standard rail impact text (MIL-STD-810)

III. (Choose one)

- A. Be marine transportable on (choose the smallest lighterage required to transport the Item: LARC-LX, LCM-8, LCU-1646, or LCU-2000) and larger vessels/ships
- B. Marine transport not required (remove blank)

IV. Must be transportable in/by (choose as many as required - If F, G, H, or I is selected, then J must be stated) aircraft.

- A. UH-1 (externally) (specify scenario)
- B. UH-60 (externally) (specify scenario)
- C. CH-47 (specify internally or externally or both as well as scenario, and by either single or dual point lift)

D. CH-53 (specify internally or externally or both as well as scenario)

E. CRAF (Civil Reserve Air Fleet) (Choose the aircraft required to transport the vehicle: (B-747, DC-8, DC-10)

F. C-130 (in its operational configuration)

G. C-141

H. C-5

I. C-17

J. Meet MIL-STD-1791

K. Air transport is not required (remove blank)

V. (Choose as many as applicable)

A. Be air droppable from (choose the required aircraft: C-130, C-141, C-5, C-17) aircraft

B. Be capable of low altitude parachute extraction (LAPES) from (choose the required aircraft: C-130, C-17) aircraft

C. Be air transportable (or air transportable on the C-5 or other specific aircraft) without the need for load spreading or approach shoring

D. At least (specify number of items) shall be capable of transport in one (specify model(s) of aircraft)

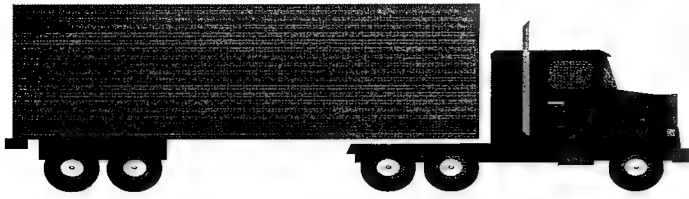
E. (If equipment is a system): The (name of system) shall be transportable by no more than (specify number and model of aircraft) sorties

- F. Be transportable in climatic categories (*specify from AR 70-38*)
- G. Be reduced/disassembled to transport configuration in (*specify*) minutes by (*specify*) personnel
- H. Be reassembled to operational configuration in (*specify*) minutes by (*specify*) personnel
- I. Be transportable in ANSI/ISO containers (*specify size*)
- J. Reduce/not increase deployment transport requirements of receiving military unit(s)
- K. Be transportable on/by (*specify*) transport vehicle

- L. Be transportable at maximum GVW (gross vehicle weight) during (*choose mode(s) (highway, air, rail, marine, all-mode)*) transport

- M. (*Specify other specific transportation limitation(s)*)

EXAMPLE: The system must meet US and NATO countries' highway legal limits; have military standard lifting and tiedown provisions; meet the GIC (Gabarit International de Chargement) rail outline diagram; pass the military standard rail impact test; be marine transportable on the LARC-LX and larger vessels/ships; be transportable by a UH-60 helicopter in the high-hot scenario (4,000 ft - 95°F); be C-130, C-17, C-141, and C-5 transportable in an operational configuration; meet MIL-STD-1791; be air droppable from C-130, C-17, and C-141 aircraft in an operational configuration; reduce/not increase the deployment transport requirements of the receiving units.



SECTION III



TRANSPORTABILITY DESIGN



5. DO'S AND DON'TS OF DESIGN

GENERAL

The goals of transportability design and the characteristics an item of equipment should have to ensure the item can be efficiently transported are discussed in this chapter. Also included are the Do's and Don'ts of transportability design.

- **DESIGN GOALS**
- **DO'S AND DON'TS**

DESIGN GOALS

When the military is developing or buying a system, one of the key considerations for combat and materiel developers should be transportability. If the ability to move the system is not carefully considered while the system is being designed or purchased, the result may be transportation problems that reduce the system's operational effectiveness. Strategic and tactical deployability are based on good transportability engineering. Developers must understand the impact of deployment, payload, and mobility requirements on the systems they intend to field.

Efficient transport is not something that evolves by itself. The equipment designer must make a conscious effort to ensure that the equipment has design features that will allow it to be efficiently transported. Developers must consider what types of units will receive the system, and what their deployment and operating requirements are. Developers must consider whether a system will operate in a combat, combat support, or combat service support role. Transportability by helicopter, good offroad mobility, and airdrop capability are generally most important for systems that are primarily oriented toward a combat or combat support role. Compliance with CONUS

and host nation legal limits, while always important, becomes particularly important for combat service support vehicles at the corps and echelons-above-corps levels.

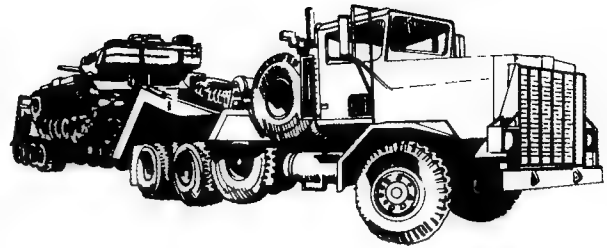
Airborne, air assault, and light infantry divisions have mission requirements that dictate that their equipment be highly deployable to and within the theater of operations. Recent exercises and low-intensity conflicts have shown a need for these units to have equipment that is transportable by helicopter and airdrop.

Overall, a CONUS-based force requires equipment that is more easily transportable. For most, if not all, future weapons systems, transportability will be a critical design element. The M-1 tanks in the field today weigh about 65 tons. However, the next generation of heavy armored vehicles should be designed to weigh 40 to 55 tons. Medium armored vehicles should weigh 17.5 to 22 tons and light armored vehicles should weigh only 8 to 11 tons.

Design constraints should be based on certain transportability design goals. The following are the design goals for each mode.

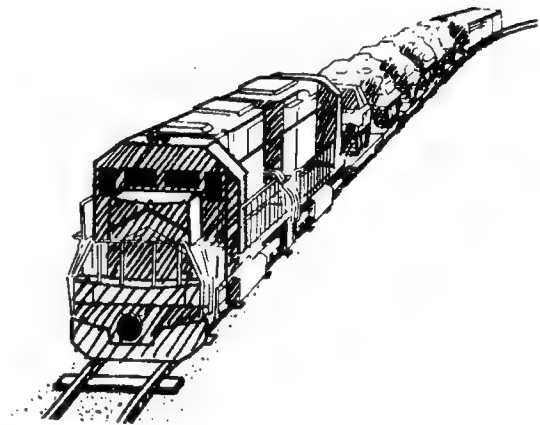
HIGHWAY TRANSPORTABILITY

- Meet legal limitations
- Achieve compatibility with user transport vehicles
- Eliminate special routing requirements
- Meet physical limitations



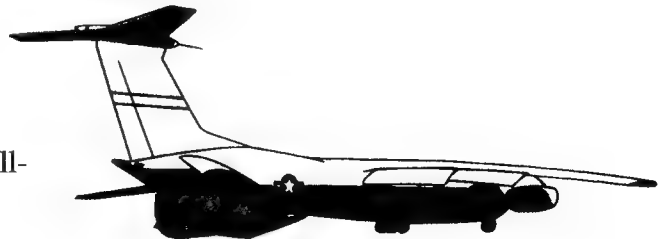
RAIL TRANSPORTABILITY

- Meet rail line clearances
- Achieve compatibility with rail equipment
- Permit efficient blocking, bracing, and tiedown
- Survive rail impacts



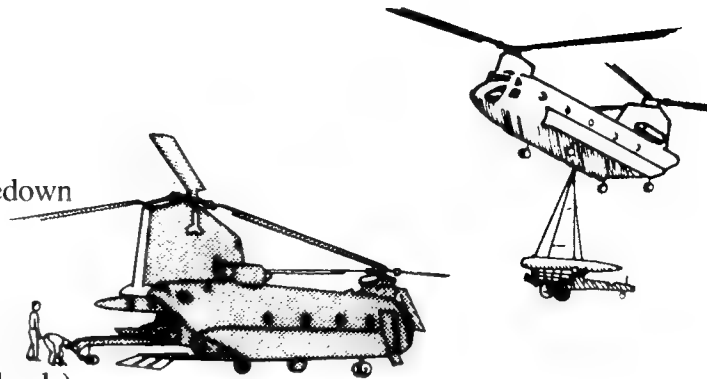
AIR TRANSPORTABILITY

- Design for C-130 or C-141 - C-5 and C-17 by exception only
- Provide tiedown points
- Minimize disassembly - design for roll-on/roll-off
- Achieve compatibility with aircraft cargo handling and airdrop systems



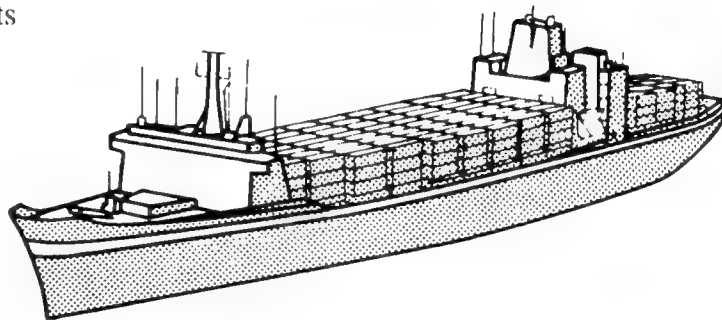
HELICOPTER TRANSPORTABILITY

- Meet aircraft limits
- Meet desired mission scenario
- Provide lift points - external loads, tiedown points - internal loads
- Ensure proper sling design
- Achieve in-flight stability (external loads)



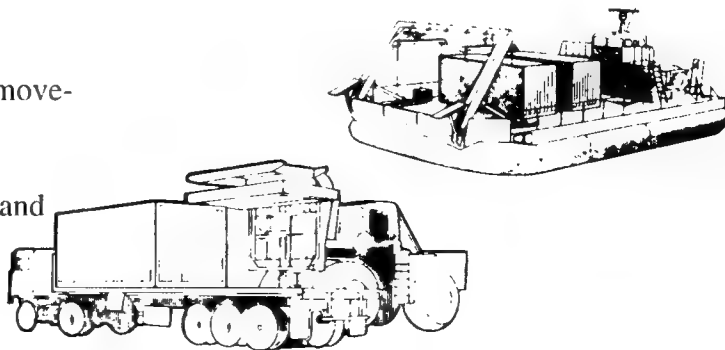
OCEAN TRANSPORTABILITY

- Provide lifting and tiedown points
- Minimize need for preservation
- Reduce the "cube"
- Maximize use of roll-on/roll-off and container ships



CONTAINERIZATION AND LOTS

- Conform to ANSI/ISO standards
- Consider offshore discharge and movement over-the-shore
- Be compatible with Army barges and lighters
- Interface with container handling equipment



DO'S AND DON'TS

Many items of equipment being procured experience the same transportability design problems. The following Do's and Don'ts are shown to prevent these problems from occurring. The best time to prevent these problems is before or during the concept exploration phase. After the concept has been turned into hardware, revision of the design to meet the transportability requirements becomes very difficult and expensive. These examples are based on previous transportability engineering analyses of military equipment.

DO

Design future armored vehicles within these weight limits:

Heavy - 40-55 tons

Medium - 17.5-22 tons

Light - 8-11 tons



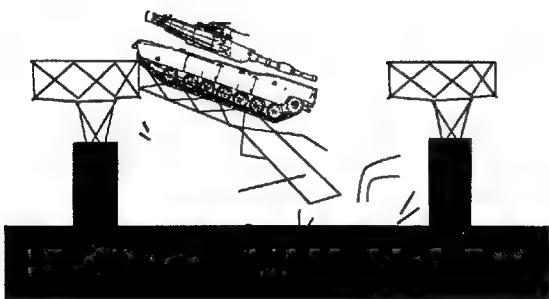
DO

Consider type of unit and its operating environment.



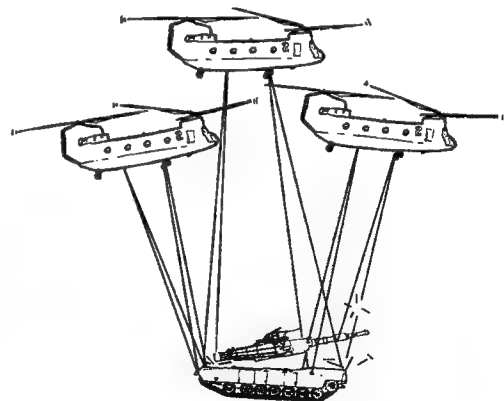
DON'T

Consider vehicle weight as an afterthought.



DON'T

Design items that cannot be lifted by helicopter and airdropped for use by airborne, air assault, and light infantry units.



DO



Design equipment to be transportable while carrying its rated payload.

DO



Design as much below the maximum weight and dimensional limits as possible to ensure transportability.

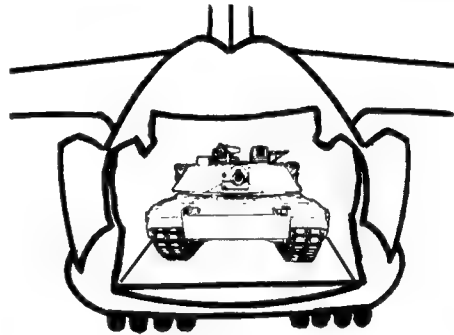
DON'T

Design equipment that is only transportable under special restricted conditions.



DON'T

Design to maximum weight or dimensional limits.



Minor weight growth or dimensional increases that typically occur during the acquisition cycle will cause the equipment to exceed maximum limits, thus negating transportability.

DO



Coordinate with MTMCTEA as soon as possible about transportability.

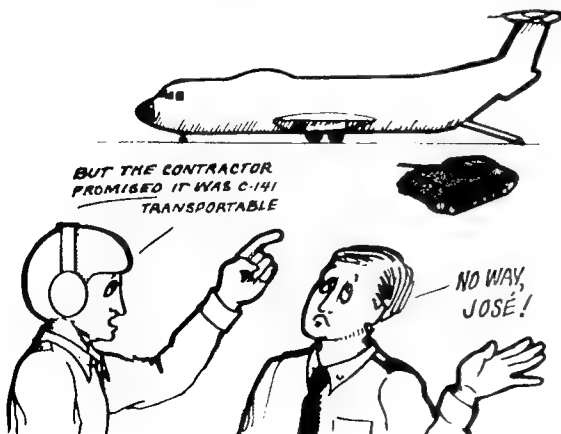
DO



Select the proper prime mover for the equipment.

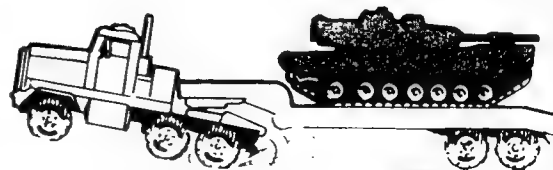
DON'T

Take the contractor's word about air transportability.



DON'T

Overload prime movers.



DO



Make sure that crew, gear, and equipment are included in the payload of a vehicle.

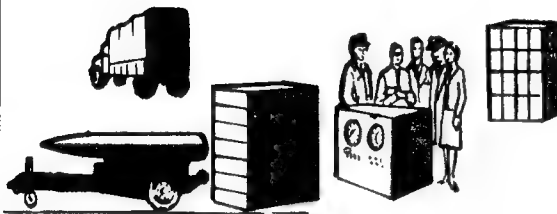
DO



Design for simplicity of lift and transport.

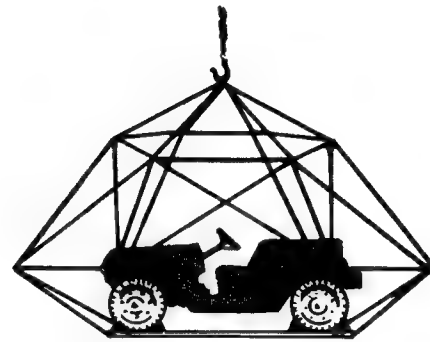
DON'T

Include just the equipment in the payload of a vehicle.



DON'T

Design equipment that requires special procedures or equipment for lifting or transport.



DO



Include information on all support equipment in requests for transportability assistance.

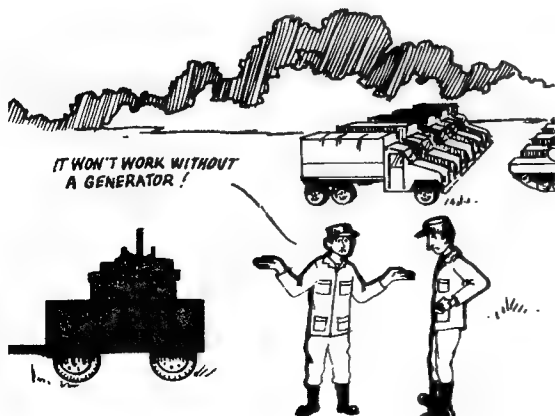
DO



Design within transport limits.

DON'T

Forget support equipment.



DON'T

Assume that transport limitations will be relaxed during deployment. (Transport limitations do not change.)



DO



Stay within the shelter limitations. Use a larger shelter if necessary.

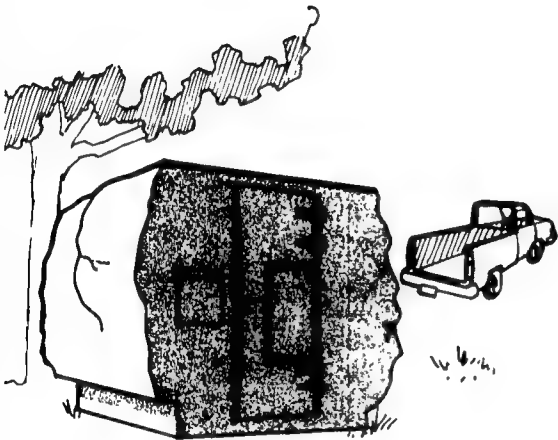
DO



Make sure that required prime movers are readily available.

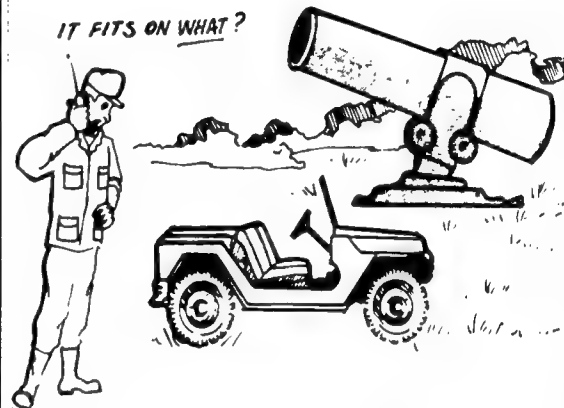
DON'T

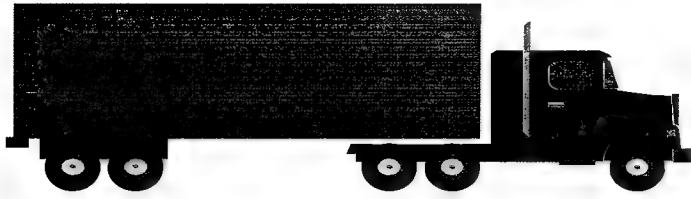
Overload shelters.



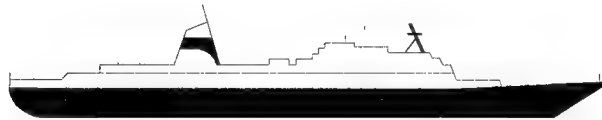
DON'T

Design equipment that require prime movers not available to the receiving unit.





SECTION IV



TRANSPORTABILITY APPROVAL



6. THE APPROVAL PROCESS

GENERAL

Transportability approval is required by **DODI 5000.2**, **AR 70-1**, and **AR 70-44/47**. This chapter provides a discussion on which items need transportability approval, how approval is requested and obtained, and what data are required for approval.

TRANSPORTABILITY APPROVAL

Developing efficiently and economically transportable equipment and combat resources will be an integral part of the acquisition process. Transportability is a critical element of strategic and tactical deployment. When strategic and tactical deployment is a system requirement, transportability will be a primary system selection and design factor.

The required type of transportability (worldwide road, rail, air, water) together with any special requirements for contingency forces, airdrop, helicopter lift, and tactical transport will be explicitly stated in the requirements documents, purchase descriptions, and specifications. MTMCTEA will review requirements documents for systems classified as problem items. Through-

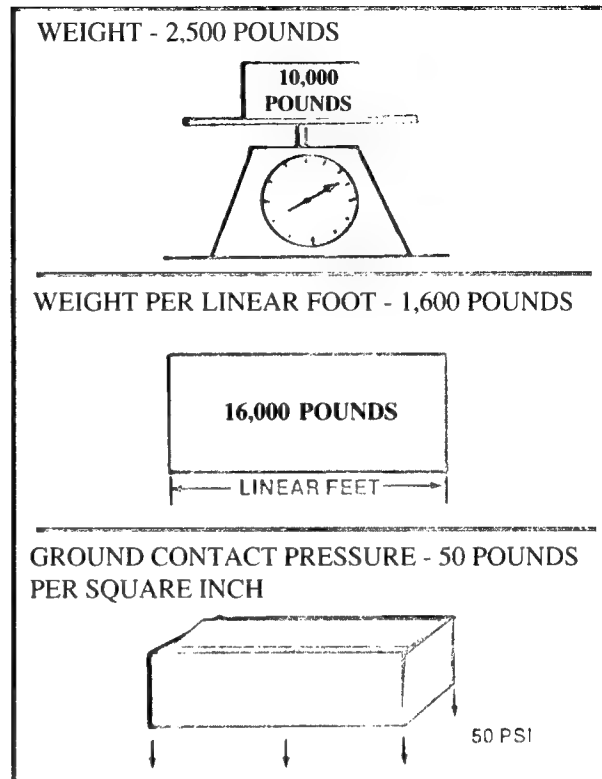
out the acquisition process, MTMCTEA monitors equipment and concurs at Milestones if the equipment is meeting its transportability requirements.

AR 70-44/47 requires transportability approval before Milestones II and III. Neither of these milestones can be passed without transportability approval from the service transportability agent. The procedures and requirements for this approval are explained in **AR 70-44/47**, *DOD Engineering for Transportability*. This chapter briefly explains what items of equipment need transportability approval, how transportability approval is requested and obtained, and what data are required for MTMCTEA to conduct a transportability engineering analysis.

WHAT IS A TRANSPORTABILITY PROBLEM ITEM?

A transportability problem item is an item that meets any of the following conditions:

1. The item is wheeled or tracked
2. The item overloads a designated transport medium.
3. The item requires special handling or specialized loading procedures.
4. The item has inadequate ramp clearance for ramp inclines of 15°.
5. Exceeds any of the following conditions:
 - (a) Length - 20 feet (6.100 m)
 - (b) Width - 8 feet (2.438 m)
 - (c) Height - 8 feet (2.438 m)
 - (d) Weight - 10,000 pounds (4535 kg)
 - (e) Weight per linear foot - 1,600 pounds (726 kg)
 - (f) Floor contact pressure - 50 psi (344.75 kpa)
 - (g) Maximum axle load (pneumatic tires) - 5,000 pounds (2268 kg)
 - (h) Maximum wheel load (pneumatic tires) - 2,500 pounds (1134 kg)
 - (i) Tire pressure - 90 psi (620.55 kpa)



NOTE: Items that are not on military units' tables of organization and/or equipment (TOE or T/E) and do not have a strategic deployment requirement are not considered transportability problem items and do not need a transportability report or transportability approval.

HOW IS TRANSPORTABILITY APPROVAL REQUESTED AND OBTAINED?

The materiel developer requests transportability approval from the service transportability agent (MTMCTEA for Army systems). A transportability report containing the transportability characteristic data required by **AR 70-44/47** should be sent to MTMCTEA at least 90 days before

approval is needed. MTMCTEA then will perform a transportability engineering analysis of the item to determine if the transportability requirements have been met. If they have been met, transportability approval will be granted.

TRANSPORTABILITY REPORT

WHAT IS A TRANSPORTABILITY REPORT?

It is a report listing all the transportability characteristics data for a transportability problem item. The transportability report provides all information necessary to perform a comprehensive transportability engineering analysis of transportability problem items. This report is submitted to MTMCTEA by the materiel developer (or a field unit). The information in the transportability report is the basis for the transportability

engineering analysis performed by MTMCTEA. For MTMCTEA to be able to perform a thorough analysis, the following information and format (taken from AR 70-44/47) is required in a transportability report. This information may be obtained by invoking data item description DI-PACK-80880, *Transportability Report*, in contracts.

FORMAT FOR TRANSPORTABILITY REPORT

(1) Title. TRANSPORTABILITY REPORT.

(2) Contract number. The assigned contract number and the latest modification number, if applicable, shall be entered.

(3) Contractor name and location.

(4) Transportability report number and date.

(5) Official nomenclature.

(6) National stock number (if assigned).

(7) Brief description.

(a) Intended use.

(b) List whether developmental items (RDT&E); NDI; Materiel Change Management Items (formerly Product Improvement Program (PIP)); rebuys; or foreign source.

(c) Specify type of military units that will use or transport the item.

(d) List theater of operations in priority order.

(8) Mode(s) of transportation.

(a) Highway. Specify if item is:

1. Self-propelled.

2. Towed.

3. Transported by truck or semitrailer. Give model numbers of required transporter(s) (for example, M920/M870, M1070/M1000, M1097).

(b) Rail. State if item will require rail transport in the United States and overseas areas. State foreign country, or countries, where rail transport is required.

(c) Ocean and waterways. State if item will require transport by ocean or waterways and provide the following information:

1. State if items will be shipped overseas in volume (unit) movements.

2. State if on-deck storage is permissible.

3. State type(s) of ship(s) (for example, breakbulk, container, roll-on/roll-off, LASH, SEABEE, waterway barge or boat).

(d) Lighterage. State the smallest lighter to be used if item is used in the logistics-over-the-shore (LOTS) environment.

(e) Air. State if item will require transport by air and provide the following information:

1. State the type(s) of fixed-wing aircraft transport required. (Air Force aircraft are C-130, C-141, C-17, and C-5.) (Civil Reserve Air Fleet (CRAF) cargo aircraft are B-747, DC-8, and DC-10.)

2. State the model number(s) of cargo helicopter(s) required. (Army utility/cargo helicopters are the UH-1, UH-60, and CH-47.) (Marine Corps helicopters are the CH-46 and CH-53.)

3. State if internal or external helicopter airlift (or both) is required. External airlift includes aerial recovery of damaged and undamaged items of equipment (vehicles or aircraft).

4. State the helicopter mission requirements (time and distance of mission, atmospheric condition requirements - 95° F at 4,000 feet, 60° F at sea level, and so forth).

5. State if internal or external airlift (or both) is required by tiltrotor aircraft. External airlift includes aerial recovery of damaged and undamaged items of equipment (vehicles or aircraft).

(f) Intermodal containers. State the following information:

1. Length of the container(s) required (for example, 10, 20, 24, 30, 35, 40, or 45 feet).

2. American National Standards Institute/International Organization of Standardization (ANSI/ISO) designation of container(s) required.

(g) Specialized service and equipment. State if special railcars, highway vehicles, or materials handling equipment are required (bilevel or tri-level railcars, shock mitigation system, spreader bars, slings, and so forth).

(h) Planned quantity. State item acquisition quantity by fiscal year.

(i) Shock and vibration. State the fragility, shock, and vibration considerations required.

(j) Special requirements. State any special considerations, including where relevant:

1. Temperature limits.
2. Pressure limits.
3. Power source required during shipment.
4. Humidity control.
5. Protective service/sensitive/classified.
6. Other requirements.

(k) Hazardous materials. For each item classified as hazardous material, state:

1. The class of hazardous material as specified in: *Title 49, Code of Federal Regulations* (49 CFR), Parts 100-179, *Transportation*; **AFR 71-4, Preparing Hazardous Materials for Military Air Shipments**; International Maritime Organization (IMO), International Maritime Dangerous Good (IMDG) code; or International Civil Aviation Organization (ICAO) Technical Instruction for the Safe Transportation of Dangerous Goods by Air.

2. DOT proper shipping name.
3. Net explosive weight (DOT class A or B explosives only).
4. Venting requirements.
5. Grounding requirements.
6. Any other than above.

(l) Regulatory requirements. Describe data to show compliance with regulatory

requirements 49 CFR, **AFR 71-4**, IMO Code, and ICAO Technical Instructions.

(m) Sectionalization. State if the item can be sectionalized, folded, or reduced for transport. All data specified in this report that are required for the operational problem item are required for each component(s) or subassembly that exceeds the criteria outlined in 4.1 of **MIL-STD-1366**. Also, provide the following information for all components or subassemblies:

1. Time and personnel required to disassemble at departure site and reassemble at destination (Time: in work and clock hours).

2. Special equipment or tools required for sectionalization (for example, cranes, forklifts, wrecker trucks, pallets, nitrogen, hand tools, calibration equipment, or fixtures).

(n) Manufacturer location. State the following information:

1. Location of manufacturer.
2. Location of final assembly.
3. Required modes of transport.

(o) Special materials handling equipment (MHE). Describe any specialized MHE required to support movement (for example, spreader bars, slings, forklifts, or cargo loaders).

(p) Transportability tests. A copy of test report(s) (or test plan and scheduled date(s) if not completed) shall be included as a part of this report, when available.

(q) Speed requirements. State self-propelled or towed speed requirements.

(r) Shipping data. A paper copy of shipping data plate that will be secured to the vehicle shall be included with this report, when available (see MIL-STD-209).

(s) Transport configuration for wheeled vehicles. Two sets of data for wheeled vehicles are required: one for the fully operational configuration (includes fuel, lubricants, water, and so forth), and one for the shipping (reduced or sectionalized) configuration.

1. Drawings. Indicate top, plan, side, and end view configurations on a MIL-T-31000 or similar engineering drawing(s). Drawings must include all data as shown in figure 1 (length, width, height, and location of Center of Gravity (CG)) on all three views.

2. Weight. State four weights (operational empty, operational loaded (maximum gross vehicle weight (MGVW)), shipping empty, and shipping loaded).

3. Weight ratings. Specify the gross vehicle weight rating (GVWR).

4. Lifting and tiedown provisions. State the number, location and strength (yield and ultimate) of lifting (including aerial recovery) and tiedown provisions for the item and major components removed for transport. Identify the location of hardpoint lifting provisions provided for aerial recovery. State if the lifting provisions meet criteria of MIL-STD-209 and interface with all standard aerial recovery and sling components. Dimensional location of lifting and tiedown provisions (with respect to the CG) shall be shown in each view required in figure 1.

5. Projections. State the dimensions and locations of any significant projections (for example, environmental control units, ladders, antennas, shelters, and so forth).

6. Tires. State the number, size(s), number of plies, load rating(s), locations, and inflation pressure of tires.

7. Axle loads. State the axle loads for each axle for the following:

a. Empty vehicle.

b. Loaded vehicle.

8. State axle ratings for each axle.

9. Suspension ratings. State load ratings for each suspension.

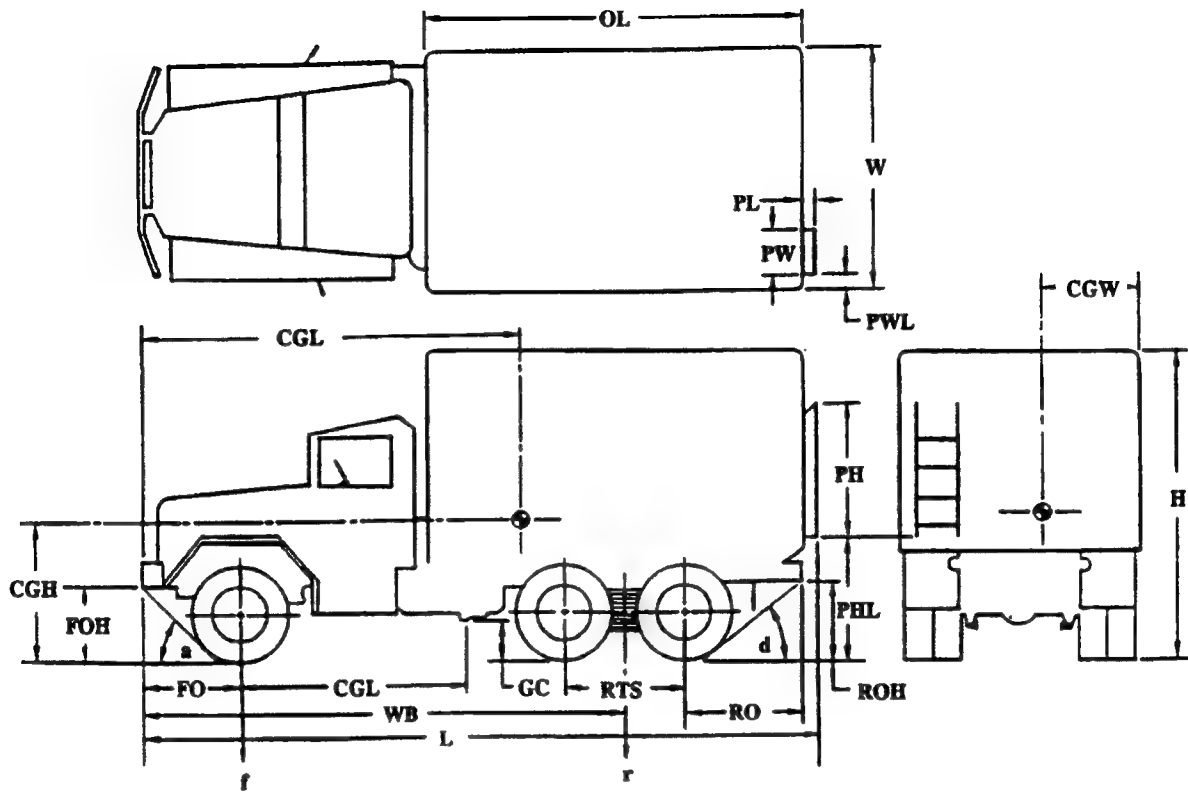
10. Tire footprint area. State the locations and dimensions of all tire footprint areas actually in contact with the ground in the fully loaded condition (fig 2).

11. Crest Angle. State the angle (in degrees) connecting two horizontal surfaces that the vehicle can pass (crest) without interference (fig 3).

12. Axle tracking width. State the tracking width of each axle (fig 4).

13. Vehicle turning diameter. State the vehicle turning diameter for the following:

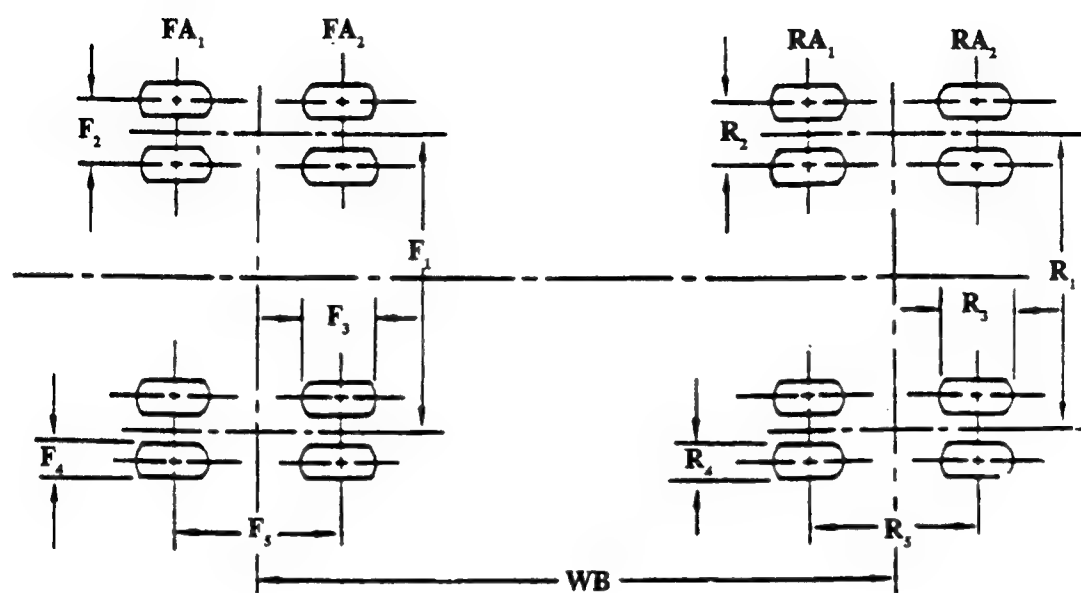
a. Wall-to-wall.



LEGEND

OL - OVERALL LENGTH BODY	WB - WHEEL BASE
W - OVERALL WIDTH	FO - FRONT OVERHANG
PW - PROJECTION WIDTH	FOH - FRONT OVERHANG HEIGHT
PWL - PROJECTION WIDTH LOCATION	RO - REAR OVERHANG
PH - PROJECTION HEIGHT	ROH - REAR OVERHANG HEIGHT
PHL - PROJECTION HEIGHT LOCATION	GC - GROUND CLEARANCE
PL - PROJECTION LENGTH	GCL - GROUND CLEARANCE LOCATION
H - OVERALL HEIGHT	RTS - REAR TIRE SEPARATION
L - OVERALL LENGTH	a - ANGLE OF APPROACH
CGL - CENTER OF GRAVITY LENGTH	b - ANGLE OF DEPARTURE
CGW - CENTER OF GRAVITY WIDTH	f - FRONT AXLE LOAD
CGH - CENTER OF GRAVITY HEIGHT	r - REAR AXLE LOAD

Figure 1. Wheeled vehicle dimensions.



LEGEND

FA - FRONT AXLE

RA - REAR AXLE

WB _____

F₁ _____

R₁ _____

F₂ _____

R₂ _____

F₃ _____

R₃ _____

F₄ _____

R₄ _____

F₅ _____

R₅ _____

Figure 2. Tire footprint locations and dimensions.

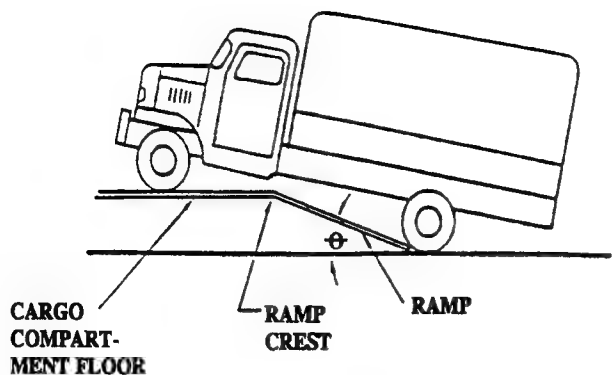


Figure 3. Ramp crest angle.

b. Curb-to-curb.

14. Load classification number.

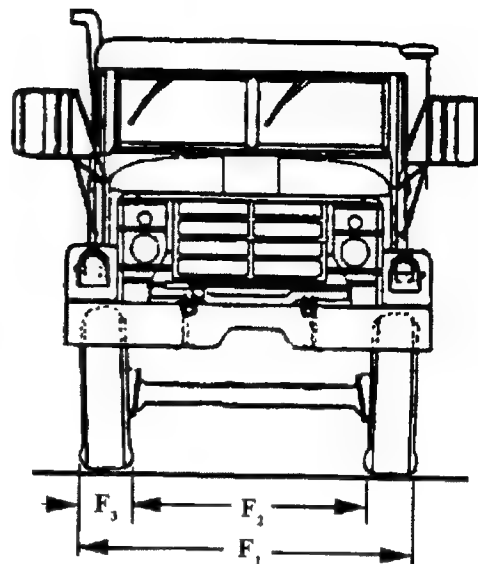
State the military load classification number (for military bridges, see chaps 2 and 4 and app C of FM 5-36):

a. Load classification number - empty weight.

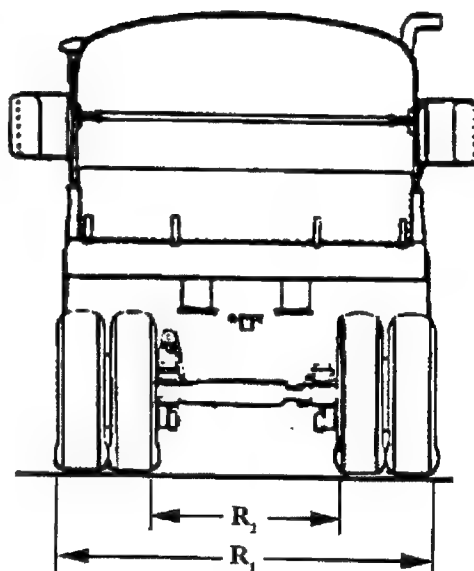
b. Load classification number - loaded weight.

(t) Transport configuration for tracked vehicles. Two sets of data for tracked vehicles are required: one for the fully operational configuration to include fuel, lubricants, water, and so forth, and one for the shipping (reduced or sectionalized) configuration.

1. Drawings. Indicate top, side, and end view configurations on a MIL-T-31000 or similar engineering drawing(s). Drawings must include all data as shown in figure 5 (length, width, height, and location of CG) on all three views.



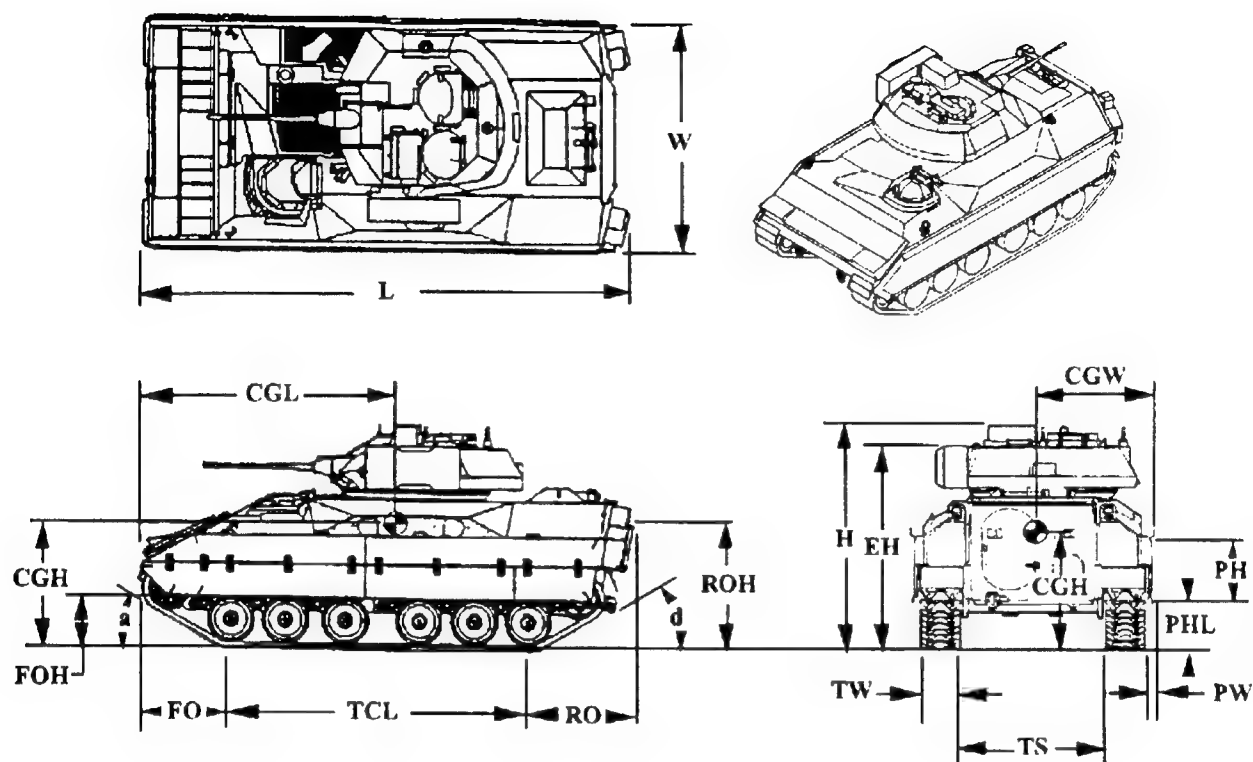
FRONT VIEW



REAR VIEW

F₁ - OUTSIDE DISTANCE
F₂ - INSIDE DISTANCE
F₃ - TIRE WIDTH
R₁ - OUTSIDE WIDTH
R₂ - INSIDE DISTANCE

Figure 4. Tracking width.



LEGEND

H	- OVERALL HEIGHT	ROH	- REAR OVERHANG HEIGHT
W	- OVERALL WIDTH	TW	- TRACK WIDTH
L	- OVERALL LENGTH	PH	- PROJECTION HEIGHT
CGL	- CENTER OF GRAVITY LENGTH	PW	- PROJECTION WIDTH
CGW	- CENTER OF GRAVITY WIDTH	PHL	- PROJECTION HEIGHT LOCATION
CGH	- CENTER OF GRAVITY HEIGHT	TS	- TRACK SEPARATION
TCL	- TRACK CENTER LINE	EH	- EDGE HEIGHT
FO	- FRONT OVERHANG	a	- ANGLE OF APPROACH
RO	- REAR OVERHANG	d	- ANGLE OF DEPARTURE
FOH	- FRONT OVERHANG HEIGHT		

Figure 5. Tracked vehicle dimensions.

2. Weight. State two weights (shipping and combat loaded (MGVW)).

3. Lifting and tiedown provisions. State the number, location, and strength (yield and ultimate) of lifting and tiedown provisions for the item, and major components removed for transport. Dimensional location of lifting and tiedown provisions (with respect to the CG) shall be shown in each view required in figure 5.

4. Projections. State the dimensions and locations of any significant projections (for example, antennas, gun tubes, weapon mounts, and so forth).

5. Track pads. State the area and number of track shoe pads actually in contact with the ground (fig 6).

6. Ground Pressure. Specify the ground pressure created by the heaviest pad (pounds per square inch). State the weight supported by each road wheel.

7. Load classification number. the military load classification number (for military bridges, see chaps 2 and 4 and app C of **FM 5-36**):

a. Load classification number - shipping weight.

b. Load classification number - combat-loaded weight.

(u) Transport configuration for skid-mounted equipment. Two sets of data for skid-mounted equipment are required: one for the fully operational configuration (includes fuel,

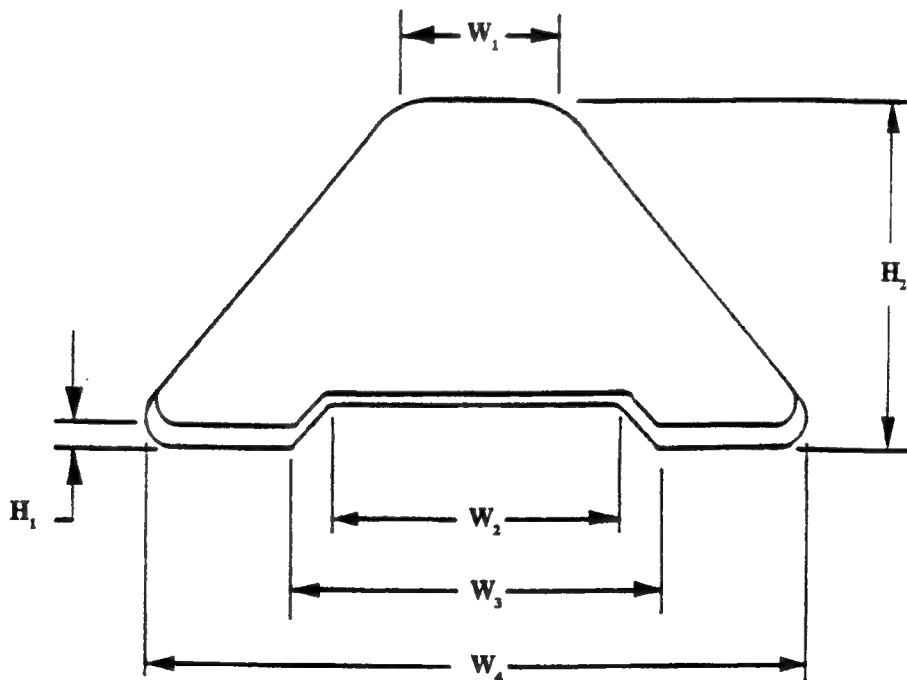


Figure 6. Track shoe pad dimensions (footprint data).

lubricants, water, and so forth), and one for the shipping configuration.

1. Drawings. Indicate top, side, and end view configurations on a MIL-T-31000 or similar engineering drawing(s). Drawings must include all data as shown in figure 7 (length, width, height, and location of CG) on all three views.

2. Weight. State two weights (shipping and operational (Maximum Gross Weight (MGW))). Operational (MGW) weight includes fuel, lubricants, water, and so forth.

3. Lifting and tiedown provisions. State the number, location, and strength (yield and ultimate) of lifting and tiedown provisions for the item and major components removed for transport. Dimensional location of

lifting and tiedown provisions (with respect to the CG) shall be shown in each view required in figure 7.

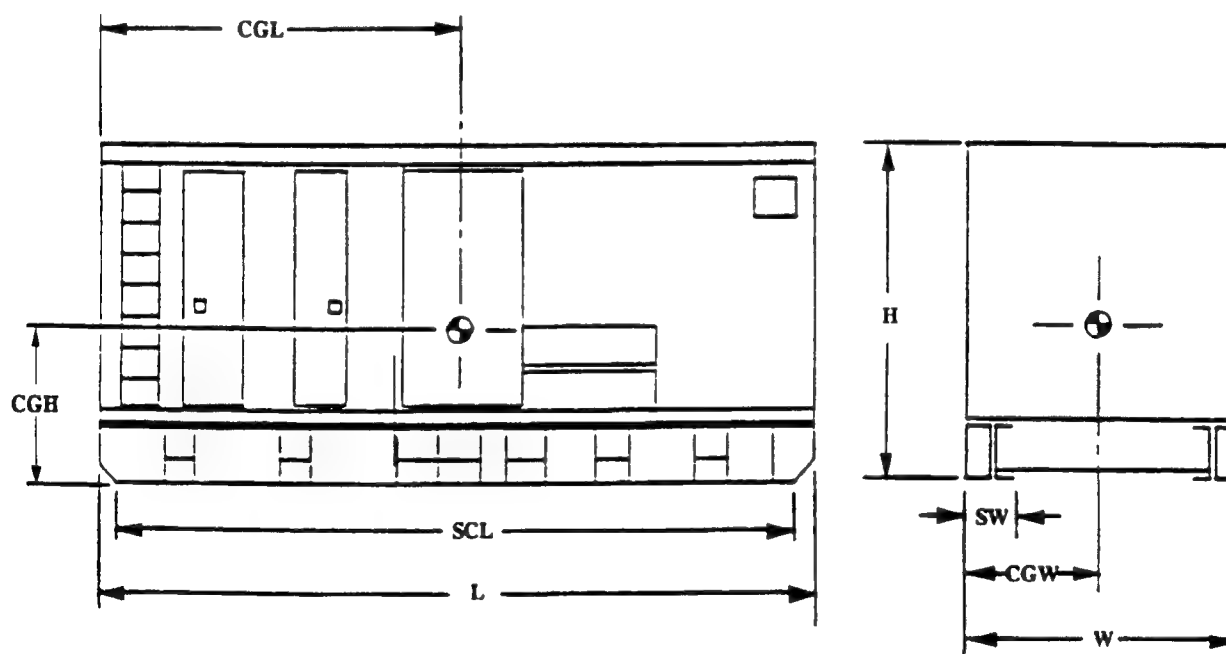
4. Projections. State the dimensions and locations of any significant projections (for example, air conditioner units or other externally mounted items).

5. Skids. Information on skids shall include the following:

a. Number of skids.

b. Dimensions of all skid areas actually in contact with the ground.

(v) Transport configuration for all other equipment. Two sets of data for the equipment (other than wheeled, tracked or skid-



LEGEND

SCL - SKID CHAMBER LENGTH
SW - SKID WIDTH
L - OVERALL LENGTH
W - OVERALL WIDTH

H - OVERALL HEIGHT
CGL - CENTER OF GRAVITY LENGTH
CGW - CENTER OF GRAVITY WIDTH
CGH - CENTER OF GRAVITY HEIGHT

Figure 7. Skid-mounted item dimensions.

mounted equipment) are required: one for the fully operational (unpackaged) configuration and one for the shipping (packaged) configuration.

1. Drawings. Indicate top, side, and end view configurations on a MIL-T-31000 or similar engineering drawing(s). Drawings must include data, as applicable, in figures 1, 5, and 7 (length, width, height, and location of CG (or center of balance) on all three views.

2. Weight. State two weights (shipping (packaged) and operational (MGW) (unpackaged)).

3. Lifting and tiedown provisions. State the number, location, and strength

(yield and ultimate) of lifting and tiedown provisions for the item and major components removed for transport. Dimensional location of lifting and tiedown provisions (with respect to the CG or center of balance) shall be shown in each view required (figs 1, 5, and 7).

(w) Subsystems or Modifications. For subsystems, support equipment, and modifications identified in 7.3 above, this report shall contain all information pertaining to the applicable subsystem and identification of the primary system(s) affected.

(x) Identification. Include the name, title, organization, or department of individual preparing the report and the date of preparation.

TRANSPORTABILITY ENGINEERING ANALYSIS

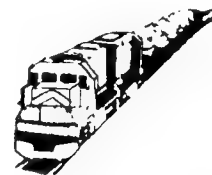
HIGHWAY

Legal limits in CONUS and foreign countries are used to determine transport limitations. Prime movers are analyzed for overloads.



RAIL

Outline diagram for standard-gauge railroads are used to determine transport restrictions. Rail-impact test results are analyzed.



MARINE

Cargo compartment dimensions and capabilities of all types of ships and Army barges and lighters are used to determine adequacy for item transport.



AIR (FIXED WING)

Transport in C-130, C-141, C-17, C-5, and Civil Reserve Air Fleet aircraft is analyzed by the US Air Force. Airdrop and LAPES are analyzed by Natick RD&E Center. Strategic mobility analyses are performed by MTMCTEA.



AIR (ROTARY WING)

Rotary wing aircraft characteristics are used to determine the item's capability for internal transport and external lift. Rotary wing transport is analyzed by Natick RD&E Center.



CONTAINERIZATION

Standard-size ISO/ANSI container characteristics are used if the item can be containerized.



LIFTING AND TIEDOWN PROVISIONS

These provisions are analyzed to ensure compliance with MIL-STD-209, MIL-STD-814, MIL-STD-913, and MIL-STD-1791.

NEED TRANSPORTABILITY GUIDANCE?

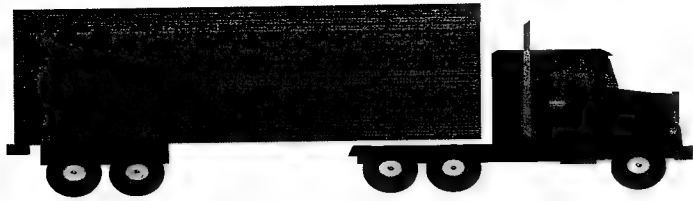
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**MILITARY TRAFFIC MANAGEMENT COMMAND
TRANSPORTATION ENGINEERING AGENCY
720 THIMBLE SHOALS BLVD, SUITE 130
NEWPORT NEWS, VIRGINIA 23606-2574**

DSN 927-4646

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(800) 722-0727



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REFERENCES

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Permits for Oversize, Overweight, or Other Special Military Movements on Public Highways in the United States

AR 70-1

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AR 70-15

Material Change Management

AR 70-38

Research Development Test and Evaluation of Material for Extreme Climate Conditions

AR 70-44

DOD Engineering for Transportability

AR 70-47

Engineering for Transportability

AR 71-9

Materiel Requirements

AR 700-127

Integrated Logistic Support

AR 1000-1

Basic Policies for Systems Acquisition

Military Standards

MIL-STD-209

Slinging and Tiedown Provisions for Lifting and Tying Down Military Equipment

MIL-STD-669

Loading Environment and Related Requirements for Platform Rigged Airdrop Materiel

MIL-STD-810

Environmental Test Methods

MIL-STD-814

Requirements for Tiedown, Suspension, and Extraction Provisions on Military Materiel for Airdrop

MIL-STD-910

Mobile Tactical Systems Overload Prevention Procedures

MIL-STD-913

Requirements for the Certification of Externally Transported Military Equipment by Department of Defense Rotary Wing Aircraft

MIL-STD-1366

Transportability Criteria

MIL-STD-1791

Designing for Internal Aerial Delivery in Fixed Wing Aircraft

Standardization Agreements

NATO STANAG No. 2154	<i>Regulations for Military Motor Vehicle Movement by Road</i>
NATO STANAG No. 2175	<i>Classification and Designation of Flat Wagons Suitable for Transporting Military Vehicles and Equipment</i>
NATO STANAG No. 2832	<i>Restrictions for the Transport of Military Equipment by Rail on European Railways</i>
NATO STANAG No. 3548	<i>Tiedown Fittings on Air Transported and Airdropped Equipment and Cargo Carried Internally by Fixed Wing Aircraft</i>
ASCC Air Standard 44/21	<i>Criteria for the Design of Equipment Transported or Airdropped from Fixed Wing and Rotary Wing Aircraft</i>

Army Pamphlets

AMC/TRADOC-P 70-2	<i>Materiel Acquisition Handbook</i>
AMC/TRADOC-P 70-7	<i>Nondevelopment Item (NDI) Acquisition Handbook</i>
DA PAM 700-127	<i>Integrated Logistic Support Manager's Guide</i>

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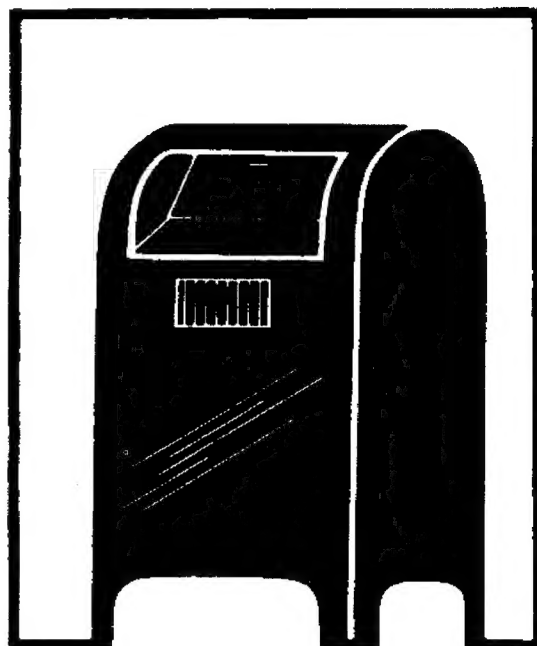
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